Research Article

Social Service Model and Value Evaluation of Libraries under Sharing Economy

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Libraries are increasingly marginalized by the information construction of electronic resources retrieval platform. This calls for a novel social service model (SSM) for libraries to enhance the overall value of their various service functions. Therefore, this paper explores the SSM and value evaluation of libraries under sharing economy. Firstly, the SSM of libraries was broken down into a base layer, a physical layer, and a virtual layer, and an evaluation index system (EIS) was constructed for the social sharing service (SSS) value of libraries. Next, the SSS value of libraries was evaluated and predicted, and the functional value of the SSM of libraries was analyzed in detail. The proposed prediction model was proved effective through experiments, and the SSS functions of libraries were valued.

1. Introduction

Libraries in China are undergoing the transform from traditional libraries and digital libraries to composite libraries, while facing the challenges of technology, operations, and popularization [1–6]. With the advancement of society, the users of libraries have expanded from students, teachers, and researchers to the public [7–9]. Unfortunately, libraries are increasingly marginalized by the information construction of electronic resources retrieval platform. This calls for a novel social service model (SSM) for libraries to coordinate their operations and enhance the overall value of their various service functions.

Using the evaluation tool of Insync Surveys, Wu et al. [10] fully considered the convenience, fairness, and public welfare of public libraries and constructed an evaluation index system (EIS) for the service quality of public libraries, which contains 28 secondary indices and 4 primary indices. Community public libraries are the basic unit that provides cultural service to the grassroots. Their development involves numerous factors [11–13]. To complement government fiscal investment, Siregar and Dewiyana [14] optimized the public cultural service system, built up a public-private partnership (PPP) service supply model for libraries, and

analyzed the intrinsic logic of introducing the model. After in-depth discussion on the basic attributes of national libraries, Handoko and Girsang [15] determined the rights and obligations between the government, libraries, and enterprises, systematically sorted out the public cultural service responsibilities of libraries, and evaluated the possible operating risks. Through case analysis and questionnaire survey, Singh et al. [16] assessed the information level of college libraries from the angles of physical supporting electronic resources, the number of electronic journals databases, and the level of management platform construction.

Public libraries provide public welfare services, which vary from region to region [17–20]. Based on the theories of public products and fairness, Karna et al. [21] quantified and empirically analyzed problems like the supply equalization of public libraries and formulated a solution from both input and output. To provide the public with rich cultural services, it is necessary to realize innovative development and transform of digital cultural services for public libraries [22–25]. Kourai and Sannomiya [26] summarized the connotations, features, forms, and service states of digital cultural services, defined several evaluation bases for the digital cultural service utility of public libraries, namely, the

full coverage of disciplines, content innovation, facility intelligence, and activity diversity, and specified the idea of setting up the corresponding EIS. Soares-Silva et al. [27] analyzed the factors affecting the knowledge service performance of public libraries from six aspects: personnel, funds, facilities, resources, activities, and effects.

In the context of open access, innovative service models, which emerged in libraries in North America and Europe, have developed gradually, and the library community in China also paid a high attention to information sharing spaces. At present, information sharing, as a support environment, is the mainstream innovative service model of libraries in the digital age. After reviewing the domestic and foreign literature on library service models, it can be inferred that both library service model and management strategy originate in the West. By contrast, China faces prominent defects in the development and application of library SSM. In fact, the evaluation of service model value has just started in China. No scholar has attempted to apply the management idea of sharing economy to library SSM. Therefore, this paper explores the SSM and value evaluation of libraries under sharing economy. Section 2 details the library SSS, which includes a base layer, a physical layer, and a virtual layer. Section 3 sets up an EIS for the SSS value of libraries. Section 4 evaluates and predicts the SSS value of libraries. Section 5 analyzes the functional value of the SSM of libraries. Through experiments, the authors proved the effectiveness of the proposed prediction model and quantified the values of the SSS functions of libraries.

This paper improves and enriches the social service model (SSM) and value evaluation method of traditional libraries. On the one hand, the utilization of university library resources was visually displayed in a digital way. On the other hand, targeted opinions and suggestions were presented for optimizing the resource allocation of libraries. Suffice it to say that this paper is a meaningful attempt to maximize the utilization value of university library resources.

2. SSS of Libraries

In the context of sharing economy, the key lies in exerting the sharing service effects of the SSS system for libraries, which integrates rich technology, information, and human resources. The SSS process of libraries covers the entire procedure of knowledge sharing and spans across every link of SSS, namely, knowledge identification, fusion, extraction, and application. Combined with the planned SSS strategy of libraries, the traditional borrowing model should be transformed into SSS through step-by-step construction and implementation. Therefore, this paper proposes the framework of SSS system for library (Figure 1), which encompasses four core elements, namely, social sharing resources, social sharing technologies, social sharing processes, and social sharing strategies.

Traditionally, library information service centers around information resources. The rich information resources give libraries the dominance in information service. However, the information resource-centred information service model
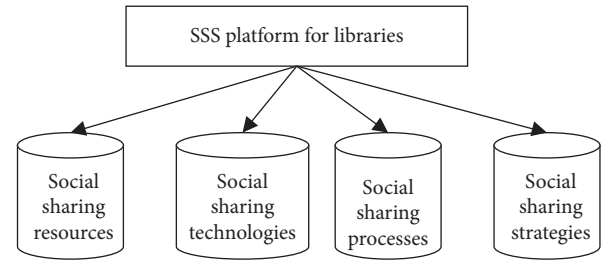

Figure 1: Framework of the SSS system for libraries.

is breaking down, as changes have taken place in the carrier form and communication method of literature information. Libraries have a wide range of physical books and e-books. The different types of resources differ vastly in attributes. To facilitate the SSS of libraries, it is necessary to establish a sharing mechanism for each kind of entities and electronic resources. During the construction of social sharing resources for libraries, the social service means should be diversified to offer varied service items and contents. Figure 2 illustrates the structure of knowledge sharing service chain, which, to some degree, reflects the construction procedure of the social sharing resources for libraries following the law of knowledge transform. It can be inferred that the orderly management of knowledge flow is a chained procedure of knowledge sharing service, including knowledge identification, knowledge extraction, knowledge fusion, knowledge visualization, knowledge storage, and knowledge sharing.

Specifically, the SSS procedure of libraries consists of four stages, namely, survey on sharing demand, formation of knowledge chain, implementation of knowledge sharing, and application of mature knowledge (Figure 3).

As shown in Figure 3, the survey on sharing demand aims to identify the demand of sharing subjects for knowledge innovation. Each sharing subject needs to pinpoint its knowledge gaps through evaluation of its professional domain knowledge structure, required entities, and electronic resources. Then, the sharing subjects should form the willingness to share knowledge and determine their sharing strategies, demand, and opportunities.

The formation of knowledge chain is the preparatory stage of actual knowledge sharing. According to the goal of knowledge innovation, the optimal knowledge sharing subjects are selected, driven by sharing demand, the necessary physical or electronic resources are defined, and the sharing platform and environment are clarified.

The implementation of knowledge sharing refers to the sharing, transfer, and innovation of knowledge. Knowledge is accumulated, processed, transformed, and innovated in the production space, fusion space, dialog space, and practice space provided by libraries.

The application of mature knowledge refers to the verification and reapplication of knowledge after innovation. Based on the evaluated effects, sharing degree, and value of knowledge sharing, the influencing factors of the sharing process can be corrected and adjusted, such as to ensure the smoothness of the next round of knowledge sharing.
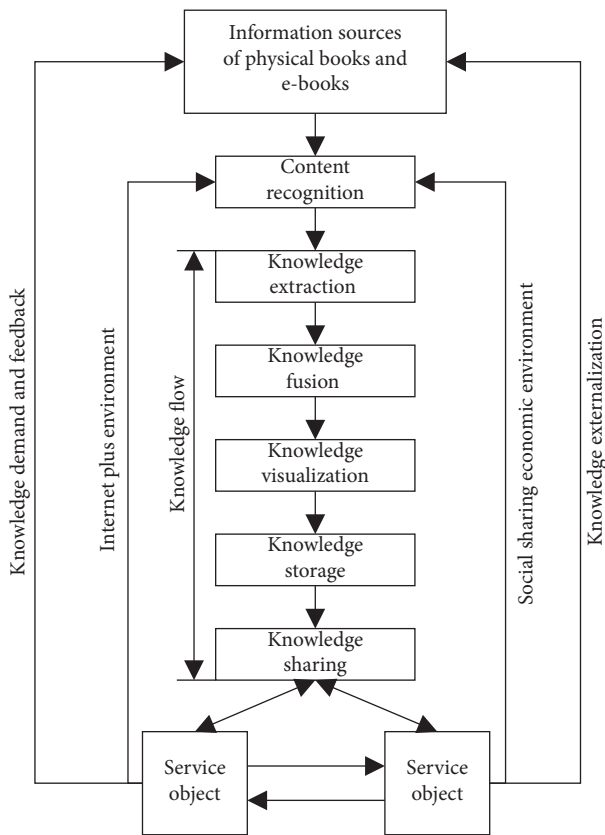
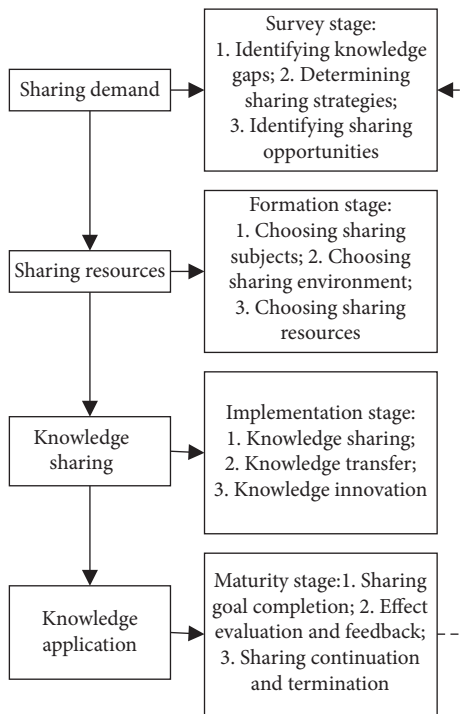FIGURE 2: Structure of knowledge sharing service chain.

FIGURE 3: Procedure of knowledge sharing service.

To survive the impact of sharing economy, libraries must adapt quickly to the trend of information sharing services. The proposal of library SSS is essentially an adaptation to the

changes in the internal and external environment of libraries. The framework of library SSS consists of a base layer, a physical layer, and a virtual layer (Figure 4).

To survive the sharing economy, libraries must quickly integrate into the wave of information sharing services. The proposal of the library SSS is actually an adaptive change to the changes in the internal and external environment of the library. Its structural framework specifically includes the basic layer, the physical layer, and the virtual layer in Figure 4.

In knowledge sharing, there are significant correlations between dimensions like library finance, social service targets, service business flow, and service development and innovation. The library SSS covers all the aspects of SSS, including sharing subjects, sharing resources, and sharing environment. In addition, the library SSS model must be designed according to how knowledge moves through the entire knowledge sharing flow from knowledge generation to knowledge innovation. In the library SSS, the regular flows of the service targets in daily learning and scientific research are fully integrated to share the physical and electronic resources of libraries and other open resources of colleges and institutions. In this way, the service targets are provided a series of services, such as the bases of resource retrieval, knowledge analysis, knowledge storage, and knowledge application. The purpose is to ensure that each service target, learning team, or research organization can smoothly acquire physical and electronic resources, and other services, fulfilling any of their knowledge demand.

3. EIS Construction

Based on the proposed library SSS model, this paper sets up an EIS for library SSS value from four dimensions: library finance, social service targets, service business flow, and service development and innovation. The EIS was constructed under the principle of scientificalness, objectiveness, and operability and in reference to the principles and standards of other SSS value EISs.

The four primary indices include the following.

$SV = \{SV_1, SV_2, SV_3, SV_4\} = \{$library finance, social service targets, service business flow, service development and innovation$\}$.

The secondary indices are as follows:

$SV_1 = \{SV_{11}, SV_{12}, SV_{13}\} = \{$profit function, resource utilization function, service guarantee function$\}$

$SV_2 = \{SV_{21}, SV_{22}, SV_{23}\} = \{$social service attributes, social image and reputation, service target demand$\}$

$SV_3 = \{SV_{31}, SV_{32}, SV_{33}\} = \{$social service quality, social service efficiency, social service tracking$\}$

$SV_4 = \{SV_{41}, SV_{42}\} = \{$social service quality, social service incentives$\}$

The secondary indices were further broken down to the following tertiary indices:

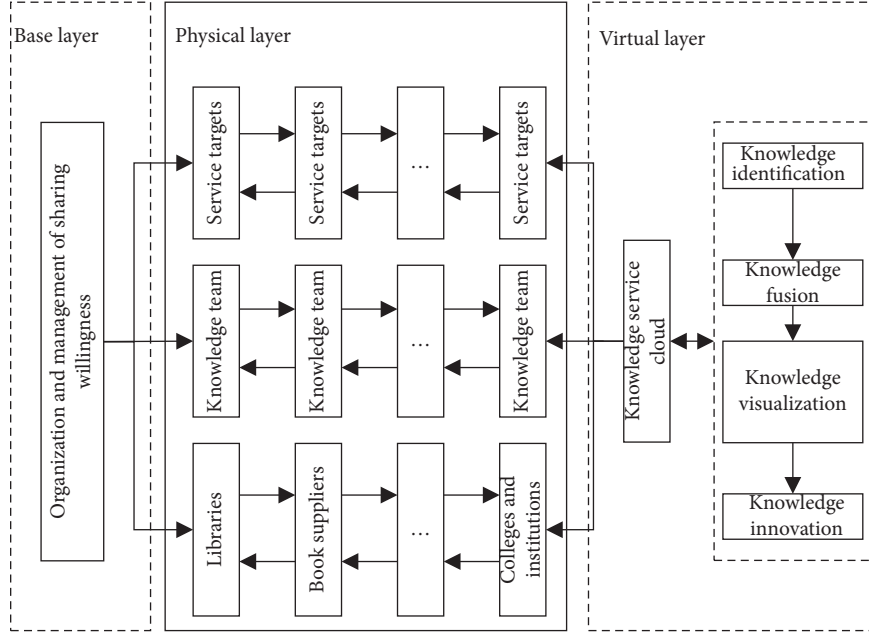$SV_{11} = \{SV_{111}, SV_{112}\} = \{$government funds on books, per-capita book funds under sharing economy, profits

FIGURE 4: SSS of libraries.

from cultural and creative products or other consumption models}

$SV_{12} = \{SV_{121}, SV_{122}\}$ = {utilization rate of public places, utilization rate of public facilities, utilization rate of audio-visual equipment, book circulation rate}

$SV_{13} = \{SV_{131}, SV_{132}, SV_{133}\}$ = {building area, book volume, characteristic literature volume}

$SV_{21} = \{SV_{211}, SV_{212}, SV_{213}, SV_{214}, SV_{215}, SV_{216}\}$ = {opening time, open reading rate, interlibrary loan and document delivery, electronic resource coverage, daily service time}

$SV_{22} = \{SV_{221}, SV_{222}\}$ = {daily shared information, daily served persons}

$SV_{23} = \{SV_{231}, SV_{232}, SV_{233}, SV_{234}\}$ = {discipline coverage rate, personal borrowing quantity limit, duplicate checking service rate, e-book provision rate}

$SV_{31} = \{SV_{311}, SV_{312}, SV_{313}\}$ = {book integrity rate, electronic resource database recall rate, book missing rate}

$SV_{32} = \{SV_{321}, SV_{322}, SV_{323}\}$ = {book borrowing cycle, per-capita download frequency of electronic resources, per-capita frequency of consultation service}

$SV_{33} = \{SV_{331}, SV_{332}\}$ = {service target satisfaction rate, satisfaction rate of book borrowing or electronic resource demand, venue and environment satisfaction rate}

$SV_{41} = \{SV_{411}, SV_{412}\}$ = {proportion of student users, proportion of teaching and research personnel, proportion of users with medium and senior professional titles}

$SV_{42} = \{SV_{421}\}$ = {on-the-job training hours for library practitioners}

4. Value Evaluation and Prediction

4.1. Basic Prediction Model. This paper establishes a fuzzy neural network (FNN), which encompasses such four layers as an input layer, a membership function layer, a rule layer, and an output layer (Figure 5).

Suppose the input layer of the FNN has a total of m nodes. Then, the evaluation indices, as input variables, can be described as $A = [a_1, a_2, \ldots, a_m]^T$. The output o of the i-th node can be calculated by

$$o_i = a_i, \quad i = 1, 2, \ldots, m. \tag{1}$$

The membership function layer contains $m \times e$ nodes, which represent Gaussian membership functions. Let λ_{ij} be the value of the j-th membership function of a_i and h_{ij} and ε_{ij} be the corresponding center and width, respectively. Then, the FNN output can be described as

$$\lambda_{ij}(a_i) = e^{-\left(a_i - h_{ij}\right)^2 / \varepsilon_{ij}^2}, \quad i = 1, 2, \ldots, m; j = 1, 2, \ldots, e. \tag{2}$$

The rule layer has a total of e nodes representing the antecedents of the fuzzy rules. The output of the j-th rule node can be calculated by

$$\Gamma_j(a) = \prod_{i=1}^{m} \lambda_{ij}(a_i) = e^{-\sum_{i=1}^{m} \left(a_i - h_{ij}\right)^2 / \varepsilon_{ij}^2}, \quad j = 1, 2, \ldots, e. \tag{3}$$
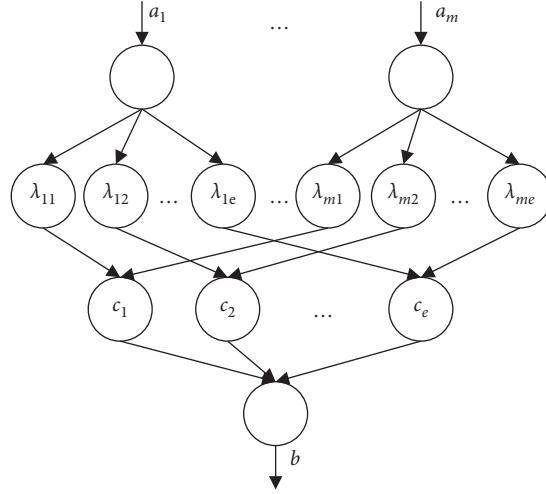
FIGURE 5: Structure of the proposed basic prediction neural network.

Let $c = [c_1, c_2, \ldots, c_m]^T$ be the normalized output vector of the rule layer. Then,

$$c_j(x) = \frac{\Gamma_j(a)}{\sum_{l=1}^{e} \Gamma_l(a)} = \frac{e^{-\sum_{i=1}^{m}(a_i - h_{ij})^2/\varepsilon_{ij}^2}}{\sum_{l=1}^{e} e^{-\sum_{i=1}^{m}(a_i - h_{il})^2/\varepsilon_{il}^2}}, \quad j = 1, 2, \ldots, e. \tag{4}$$

Let ωj be the result of the j-th rule. Then, the output of the rule layer can be solved through weighted summation of the inputs of the output layer:

$$b(a) = \sum_{j=1}^{e} \omega_j c_j = \frac{\sum_{j=1}^{e} \omega_j e^{-\sum_{i=1}^{m}(a_i - h_{ij})^2/\varepsilon_{ij}^2}}{\sum_{l=1}^{e} e^{-\sum_{i=1}^{m}(a_i - h_{il})^2/\varepsilon_{il}^2}}. \tag{5}$$

Drawing on backpropagation neural network (BPNN), the FNN can realize one-step prediction by changing a_i in formula (5) into FO(l) in formula (6), which represents the FNN output:

$$b_n(l + 1) = \sum_{j=1}^{e} \omega_j c_j = \frac{\sum_{j=1}^{e} \omega_j e^{-\sum_{i=1}^{m}(FO(l) - h_{ij})^2/\varepsilon_{ij}^2}}{\sum_{l=1}^{e} e^{-\sum_{i=1}^{m}(FO(l) - h_{il})^2/\varepsilon_{il}^2}}. \tag{6}$$

The multistep prediction model can be described by

$$b_n(l + t + 1) = \sum_{j=1}^{e} \omega_j c_j = \frac{\sum_{j=1}^{e} \omega_j e^{-\sum_{i=1}^{m}(FO(l + t) - h_{ij})^2/\varepsilon_{ij}^2}}{\sum_{l=1}^{e} e^{-\sum_{i=1}^{m}(FO(l + t) - h_{il})^2/\varepsilon_{il}^2}}. \tag{7}$$

4.2. Design of the Improved Network Model. To speed up network convergence, the structure and parameters of the proposed neural network should be recognized and estimated. The risk assessment filter (RAF) algorithm, which is based on fuzzy Gaussian kernel clustering, was adopted to automatically divide the space of the input samples of the evaluation indices. In this way, the initial fuzzy rules were extracted, and the SSS value of the target library was predicted. In the RAF algorithm, the fuzzy rules are automatically divided by the following standard: the mean variance of evaluated levels for SSM value. Suppose the evaluated levels belong to e clusters. The results were divided into five levels: excellent, good, neutral, qualified, and poor. Let $(t_{AV-j})^2$ be the mean variance of the clusters corresponding to the j-th evaluated level. Then, the evaluated level with the largest mean variance can be identified by

$$AL = \arg \max_{1 \leq j \leq w} (t_{AV-j})^2, \tag{8}$$

where $(t_{AV-j})^2$ is the sum of the variances of the index samples:

$$(t_{AV-j})^2 = \sum_{i=1}^{m} t_{ij}^2. \tag{9}$$

Let $a \in u_j$ be the membership of index sample a to the j-th evaluated level and u_{ij} and SN_j be the i-th dimensional center and the number of samples corresponding to the j-th evaluated level, respectively. Then, the corresponding variance t_{ij} can be calculated by

$$s_{ij}^2 = \frac{1}{p_j} \sum_{x \in v_j} (x_{ij} - v_{ij})^2 \quad t_{ij}^2 = \frac{1}{SN_j} \sum_{x \in u_j} (a_{ij} - u_{ij})^2. \tag{10}$$

If $s_{\text{AV-AL}}^2$ is greater than the preset threshold S^*, then the i-th cluster centering on $u_{\text{AV-AL}} = (u_{\text{AL1}}, u_{\text{AL2}}, \ldots, u_{\text{AL}m})$ will be divided into two new clusters, respectively, centering on $u_{\text{AV-AL}} + \beta$ and $u_{\text{AV-AL}} - \beta$, where β is a small positive constant.

After the division of fuzzy rules, the e clusters were calculated iteratively by the fuzzy c-means (FCM) clustering algorithm until $s_{\text{AV-AL}}^2$ falls below the preset threshold S^*.

By minimizing the second-order objective function, the FCM clustering algorithm calculates the membership of each index sample to the cluster center corresponding to each evaluated level. In this way, the evaluation index dataset was automatically classified.

Let $A = \{a_1, a_2, \ldots, a_K\}$ be the network training set, $u = \{u_1, u_2, \ldots, u_D\}$ be cluster centers, K be the number of index samples, D be the number of cluster centers, OF_n be the objective function for library SSM value, n be the fuzzy index; λ_{kd} be the membership of the k-th index sample to the d-th cluster center, and F be the feature mapping function. Then, the objective function of FCM clustering can be defined by

$$
\text{OF}_n = \sum_{d=1}^{D} \sum_{k=1}^{K} \lambda_{kd}^n \left\| F(a_k) - F(u_d) \right\|^2,
$$

$$
\text{s.t.} \sum_{d=1}^{D} \lambda_{kd} = 1, \quad 0 \le \lambda_{kd} \le 1. \tag{11}
$$

Based on the rules for kernel method transform, the feature mapping function between indices and cluster centers can be constructed as

$$
\begin{aligned}
\left\| F(a_k) - F(u_d) \right\|^2 &= (F(a_k) - F(u_d))^T (F(a_k) - F(u_d)) \\
&= F(a_k)^T F(a_k) - F(a_k)^T F(u_d) - F(u_d)^T F(a_k) + F(u_d)^T F(u_d) \\
&= \text{GN}(a_k, a_k) + \text{GN}(u_d, u_d) - 2\text{GN}(a_k, u_d).
\end{aligned} \tag{12}
$$

Let δ be the width of cluster center. Then, the Gaussian function GN in formula (12) can be defined as

$$
K(x, v) = \exp \left[-\frac{\|x - v\|^2}{b^2} \right], \tag{13}
$$

$$
\text{GN}(a, u) = e^{-\|a - u\|^2 / \delta^2}.
$$

Since $\text{GN}(a, a) = 1$, the objective function (11) can be rewritten as

$$
\text{OF}_n = 2 \sum_{d=1}^{D} \sum_{k=1}^{K} \lambda_{kd}^n (1 - \text{GN}(a_k, u_d)). \tag{14}
$$

The optimal solution of (14) can be obtained by updating u_d and λ_{kd}:

$$
u_d = \frac{\sum_{k=1}^{K} \lambda_{kd}^n \text{GN}(a_k, u_d) a_k}{\sum_{\text{MV}=1}^{\text{MV}} \lambda_{kd}^n \text{GN}(a_k, u_d)}. \tag{15}
$$

$$
\lambda_{kd} = \frac{(1 - \text{GN}(a_k, u_d))^{-1/(n-1)}}{\sum_{d=1}^{D} (1 - \text{GN}(a_k, u_d))^{-1/(n-1)}}. \tag{16}
$$

Moreover, the nonexact Lagrangian multiplier method was introduced to the proposed prediction model to enhance the convergence speed and generalization ability. Let $\Psi(\tau) = [\omega(\tau), o(\tau), \varepsilon(\tau)]$ be the vector of network parameters, Jaco be the Jacobian matrix, $v(\tau)$ be the learning rate of the network, and $\varphi(\tau) = [\varphi_1(\tau), \varphi_2(\tau), \ldots, \varphi_q(\tau)]^T$ be the error vector. Based on the traditional Levenberg–Marquardt (LM) algorithm, network parameters can be updated by

$$
\Psi(\tau + 1) = \Psi(\tau) - \left(\text{Jaco}(\tau)^T \text{Jaco}(\tau) + v(\tau)I \right)^{-1} \text{Jaco}(\tau)^T \text{WC}(\tau). \tag{17}
$$

The error of the q-th sample can be defined as

$$
\phi^q(\tau) = b_d^q(\tau) - b^q(\tau), \quad q = 1, 2, \ldots, K. \tag{18}
$$

The Jacobian matrix can be calculated by

$$
\text{Jaco} = \begin{bmatrix}
\dfrac{\partial \phi_1}{\partial \omega_1}, \cdots, \dfrac{\partial \phi_1}{\partial \omega_e}, \dfrac{\partial \phi_1}{\partial o_{11}}, \cdots, \dfrac{\partial \phi_1}{\partial o_{me}}, \dfrac{\partial \phi_1}{\partial \varepsilon_{11}}, \cdots, \dfrac{\partial \phi_1}{\partial \varepsilon_{me}} \\[2ex]
\dfrac{\partial \phi_1}{\partial \omega_1}, \cdots, \dfrac{\partial \phi_2}{\partial \omega_e}, \dfrac{\partial \phi_2}{\partial o_{11}}, \cdots, \dfrac{\partial \phi_2}{\partial o_{me}}, \dfrac{\partial \phi_2}{\partial \varepsilon_{11}}, \cdots, \dfrac{\partial \phi_2}{\partial \varepsilon_{me}} \\[2ex]
\vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots \\[2ex]
\dfrac{\partial \phi_q}{\partial \omega_1}, \cdots, \dfrac{\partial \phi_q}{\partial \omega_e}, \dfrac{\partial \phi_q}{\partial o_{11}}, \cdots, \dfrac{\partial \phi_q}{\partial o_{me}}, \dfrac{\partial \phi_q}{\partial \varepsilon_{11}}, \cdots, \dfrac{\partial \phi_q}{\partial \varepsilon_{me}}
\end{bmatrix}. \tag{19}
$$

Formula (19) shows that the number of rows and columns of the Jacobina matrix represent the number of index samples and the number of network parameters, respectively. Therefore, the computation overhead and storage volume will increase prominently with the growing number of training samples. This problem can be solved effectively by introducing the nonexact Lagrangian multiplier method. Let $\text{GH}(\tau)$ be the quasi-Hessian matrix and $\text{GV}(\tau)$ be the gradient vector. Then, parameter vector $\Psi(\tau)$ can be updated by

$$
\Psi(\tau + 1) = \Psi(\tau) - (\text{GH}(\tau) + v(\tau)I)^{-1} \text{GV}(\tau). \tag{20}
$$

Suppose α is a constant in the range of $[0, 1]$. Then, the adaptive learning rate $\upsilon(\tau)$ can be calculated by

$$\upsilon(\tau) = \alpha\|\phi(\tau)\| + (1 - \alpha)\|\mathrm{GV}(\tau)\|. \quad (21)$$

$\mathrm{GH}(\tau)$ and $\mathrm{GV}(\tau)$ can be, respectively, calculated by

$$\mathrm{GH}(\tau) = \sum_{q=1}^{K} \mathrm{GH}_q(\tau), \quad (22)$$

$$\mathrm{GV}(\tau) = \sum_{q=1}^{K} \omega_q(\tau), \quad (23)$$

where the submatrix $\mathrm{GH}_q(\tau)$ can be defined by

$$\begin{aligned} \Psi(t) &= j_p^T j_p(t), \\ \psi(\tau) &= \mathrm{KB}_q^T \mathrm{KB}_q(\tau). \end{aligned} \quad (24)$$

Let $\mathrm{Jaco}_q(\tau)$ be the row vector of the Jacobian matrix. Then, the subvector $\omega_q(\tau)$ can be defined by

$$\omega_q(\tau) = \mathrm{Jaco}_q^T \phi_q(\tau). \quad (25)$$

Then, the elements about $\omega_{ij}(\tau)$ in the row vector can be calculated by

$$\frac{\partial \phi_q(\tau)}{\partial \omega_j(\tau)} = \frac{\partial \phi_q(\tau)}{\partial b_q(\tau)} \frac{\partial b_q(\tau)}{\partial \omega_j(\tau)} = -L_j(\tau). \quad (26)$$

The elements about $o_{ij}(\tau)$ in the row vector can be calculated by

$$\begin{aligned} \frac{\partial \phi_q(\tau)}{\partial o_{ij}(\tau)} &= \frac{\partial \phi_q(\tau)}{\partial b_q(\tau)} \frac{\partial b_q(\tau)}{\partial L_j(\tau)} \frac{\partial L_j(\tau)}{\partial \xi_j(\tau)} \frac{\partial \xi_j(\tau)}{\partial \lambda_{ij}(\tau)} \frac{\partial \lambda_{ij}(\tau)}{\partial o_{ij}(\tau)} \\ &= -\omega_j(t) \frac{\sum_{r \neq j}^{R} \xi_r(t)}{\left(\sum_{r=1}^{R} \xi_r(t)\right)^2} \prod_{r \neq j}^{m} \lambda_{rj}(t) \frac{\partial \lambda_{ij}(t)}{\partial o_{ij}(t)}. \end{aligned} \quad (27)$$

The elements about $\varepsilon_{ij}(\tau)$ in the row vector can be calculated by

$$\begin{aligned} \frac{\partial \phi_q(\tau)}{\partial \varepsilon_{ij}(\tau)} &= \frac{\partial \phi_q(\tau)}{\partial b_q(\tau)} \frac{\partial b_q(\tau)}{\partial L_j(\tau)} \frac{\partial L_j(\tau)}{\partial \xi_j(\tau)} \frac{\partial \xi_j(\tau)}{\partial \lambda_{ij}(\tau)} \frac{\partial \lambda_{ij}(\tau)}{\partial \varepsilon_{ij}(\tau)} \\ &= -\omega_j(\tau) \frac{\sum_{r \neq j}^{R} \xi_r(\tau)}{\left(\sum_{r=1}^{R} \xi_r(\tau)\right)^2} \prod_{r \neq j}^{m} \lambda_{rj}(\tau) \frac{\partial \lambda_{ij}(\tau)}{\partial \varepsilon_{ij}(\tau)}, \end{aligned} \quad (28)$$

where the partial derivatives of membership relative to $o_{ij}(\tau)$ and $\varepsilon_{ij}(\tau)$ can be calculated by

$$\begin{aligned} \frac{\partial \lambda_{ij}(\tau)}{\partial o_{ij}(t)} &= \frac{2(a_i(\tau) - o_{ij}(\tau)) e^{\left(-(a_i(\tau) - \mathrm{AH}_{ij}(\tau))^2 / \varepsilon_{ij}^2(t)\right)}}{\varepsilon_{ij}^2(t)}, \\ \frac{\partial \lambda_{ij}(\tau)}{\partial \varepsilon_{ij}(\tau)} &= \frac{2(a_i(\tau) - o_{ij}(\tau))^2 e^{\left(-(a_i(\tau) - \mathrm{AH}_{ij}(\tau))^2 / \varepsilon_{ij}^2(t)\right)}}{\varepsilon_{ij}^3(\tau)}. \end{aligned} \quad (29)$$

5. Functional Value Analysis

To further analyze the SSS functional values of libraries, the SSM values evaluated by the previously established model under the sharing economy were summed up and compared with the human, financial, and material resources invested to realize the ideal values, producing the functional cost ratio of resource utilization by the SSM of each library, that is, the functional value of SSM for each library. The value management formula can be described by

$$(\text{value}) = \frac{(\text{function})}{(\text{cost})}. \quad (30)$$

Then, the SSM value of a library JXW equals the ratio of SSM functions (JXG) to social service cost (JXK) of the library:

$$\mathrm{JXW} = \frac{\mathrm{JXG}}{\mathrm{JXK}}. \quad (31)$$

During the SSM value management of libraries, it is difficult to unify the units of SSM functions and input costs, the units of the dimensions of SSM functions, or the units of the dimensions of input costs. To solve the problem, this paper introduces the relative coefficient ratio to compute the SSM value of libraries. Let η be the SSM functional coefficient and G_i be the functional value of library SSM in the i-th year. Then, the total SSM functional value of a library can be described by $\Sigma_{i=1}^{N} G_i$. Then,

$$\eta = \frac{G_i}{\sum_{i=1}^{N} G_i}. \quad (32)$$

Formula (32) shows that η is the ratio of the SSM functional value in a year to the total functional value in the research period. Let γ be the cost coefficient of social services of a library, K_i be the social service cost in the i-th year, and $\Sigma_{i=1}^{N} K_i$ be the total social service cost of the library in the research period. Then,

$$\gamma = \frac{K_i}{\sum_{i=1}^{N} K_i}. \quad (33)$$

Hence, γ is the input cost of the library in a year to the total input cost in the research period. Then, the SSM value coefficient of the library can be described as

$$\rho = \frac{\eta}{\gamma}. \quad (34)$$

6. Experiments and Result Analysis

Figure 6 compares the training error curves of BPNN, RBFN, and our model through 600 iterations. When all network parameters were the same, the training error fluctuated slightly and tended to be stable after 500 iterations. BPNN and RBFN had basically the same root mean square error (RMSE), convergence speed, and convergence accuracy. Our model surpassed them in convergence speed and accuracy.
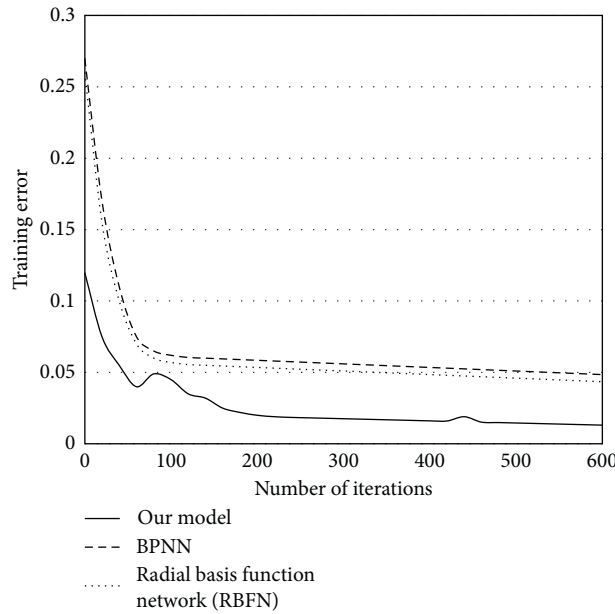
FIGURE 6: Training error curves.

This proves the effectiveness of the proposed FNN in predicting the value of library SSM.

To further verify the prediction accuracy of our FNN, the said three models were tested on the same index samples. Their prediction outputs were compared in detail. Figure 7 presents the prediction errors of the three models between the 1,000[th] iteration and 1,060[th] iteration. Our prediction model minimized the difference between the predicted SSM value and the expected SSM value, among the three models.

To realize the ideal functional value, each library needs to pay a labor cost, that is, the total salary required by the state, including the basic wage and allowances. Table 1 shows the salary payment by libraries in China to workers with different professional titles.

The financial cost of a library mainly refers to the investment in the projects under construction. It can be incurred by venue construction/expansion, the purchase of physical books, the addition of borrowing and retrieval equipment, the utilization of electronic resource databases, and operations like administration and businesses. Table 2 shows the cost incurred by the purchase of physical books, the utilization of electronic resource databases, and operations of Chinese libraries in 2015–2020.

The material cost of a library mainly refers to the physical form of the existing fixed assets, which covers venue scale, investment of existing equipment, total amount of physical books, total amount of electronic resource databases, and so on. Table 3 shows the estimated cost of library material resources in China during 2015–2020.

According to the analysis results on the SSS functional value, the SSS functions were optimal at $\rho = 1$, indicating that the model needs no adjustment or improvement. In fact, ρ is acceptable as long as it falls between 1.15 and 0.85. Table 4 shows the functional value of library SSS increased year by year; that is, the human, financial, and material invested by
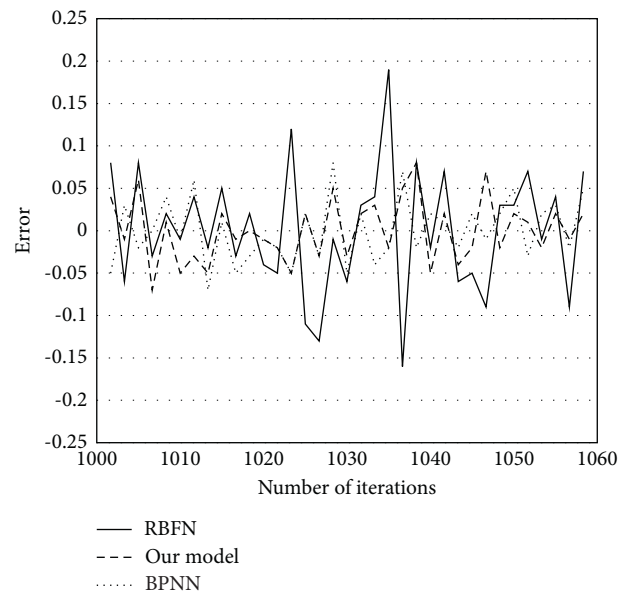

FIGURE 7: Prediction errors of different models.

TABLE 1: Labor cost of libraries in 2015–2020.

Year	Title		
	Senior	Medium	Below medium
2015	11	35	59
2016	16	32	52
2017	17	31	45
2018	19	29	42
2019	20	25	41
2020	22	21	39

libraries are effective. Through the six years, the γ value did not change much (0.283, 0.267, 0.378, 0.297, 0.316, and 0.429), suggesting that the annual income of libraries only

Table 2: Financial cost of libraries in 2015–2020.

Year	Item		
	Purchase of physical books	Utilization of electronic resource databases	Operations
2015	297.6	365.2	15
2016	312.5	377.5	17
2017	335.2	396.1	22
2018	349.4	402.3	24
2019	358.1	415.9	26
2020	376.9	428.4	29

Table 3: Material cost of libraries in 2015–2020.

Year	Item			
	Equipment investment	Venue scale	Total amount of physical books	Total amount of electronic resource databases
2015	31	41,583	201.5	68
2016	42	40,532	202.1	72
2017	45	40,532	203.9	77
2018	46	40,532	208.3	80
2019	50	40,612	214.5	86
2020	52	40,612	221.7	94

Table 4: Evaluated SSS values of libraries in 2015–2020.

Year	Item					
	Service function		Service cost		Service value	
	η	Ranking	γ	Ranking	ρ	Ranking
2015	0.297	6	0.283	5	0.832	6
2016	0.332	5	0.267	6	0.951	5
2017	0.396	4	0.378	2	1.254	3
2018	0.428	3	0.297	4	1.108	4
2019	0.475	2	0.316	3	1.443	2
2020	0.542	1	0.429	1	1.672	1

increased slightly. The growth of SSS value mainly comes from the rising functional value of SSM.

7. Conclusions

This paper explores the SSM and value evaluation of libraries under sharing economy. Firstly, the SSS of libraries was modeled as a system of a base layer, a physical layer, and a virtual layer, and an EIS was constructed for library SSS. Next, an improved FNN was established to evaluate and predict the SSS value of libraries, followed by an analysis on the functional value of library SSS. Through experiments, the training error of our model through 600 iterations was compared with that of BPNN and RBFN. The comparison confirms the effectiveness of our prediction model. Further, the SSS functional value was evaluated for libraries, leading to the conclusion that the growth of SSS value mainly comes from the rising functional value of SSM.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

Acknowledgments

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