Analysis of the Website Information Architecture of Sun Yat-sen Library of Guangdong Province Based on Interpretative Structural Modeling

Zhinan Qin
Yangjiang Campus Library, Guangdong Ocean University, Yangjiang, Guangdong, China

Abstract: The Interpretative Structural Modeling (ISM) method can effectively analyze the relationship between influencing factors through matrix operations and present the interaction path and hierarchical structure in the form of visual directed graphs. This paper used the ISM method to study the website information architecture of Sun Yat-sen Library of Guangdong Province. The research shown that the website presented resources and service intuitively in a flat information architecture with short search path of information, and provided differentiated service through a clear authority division mechanism. This website information architecture was helpful to optimize the navigation structure, reduce users' cognitive load, enhance the website browsing rate and improve the service efficiency. This paper explored the application of the ISM method in the field of library website design, and expanded the application scope of the ISM method in complex system research. In addition, it also provided decision-making basis for user experience design of library websites.

Keywords: Library Website; Information Architecture; Interpretative Structural Modeling; Hierarchical Structure

1. Introduction

Driven by the rapid development of information technology, libraries in China and abroad have built many kinds of knowledge service systems and information resource dissemination platform. As an important carrier to realize digital transformation, library websites provide users with diversified service, enhancing the utilization of digital resources and the convenience of service [1,2].

However, the design of some library websites paid more attention to internal management needs and failed to fully consider the actual needs of library users [3], leading to problems in information architecture, such as complex content, chaotic navigation and unclear core service entrance. Users encountered difficulty in finding information and failed to complete cumbersome operation, which reduced the utilization of digital resources and service efficiency. A good design of library website should be based on user needs, organize information in a systematic way, establish a hierarchical category and formulate an intuitive navigation, in order to optimize information accessibility [4,5].

As a common analysis method in the field of modern system engineering, the Interpretive Structural Modeling (ISM) method can be an efficient tool to analyze and evaluate the information architecture of library websites. It builds a hierarchical topology based on matrix operations to visualize the classification and hierarchy of information, which can be used as a design reference to reduce the cognitive burden and optimize the user experience [6].

2. The Interpretive Structural Modeling (ISM) Method

In 1974, John N. Warfield pioneered the application of Interpretative Structural Modeling (ISM) method to complex system research [7]. After continuous optimization and improvement by subsequent scholars, the ISM method has gradually evolved into an efficient, universal and practical systematic analysis technology and is widely used in system engineering. It transforms the internal correlation mechanism into a topological structure through mathematical operations, and shows the correlation and hierarchical relationship between system factors using visual directed graphs, providing a basis for complex systems optimization and decision analysis [8-10].

Implementing the ISM analysis involves the following steps:
(1) Determine the system factors;
(2) Construct the adjacency matrix;
(3) Calculate the reachable matrix;
(4) Divide regions and levels;
(5) Construct an interpretative structural model.

3. Research Object

The research object was the website of Sun Yat-sen Library of Guangdong Province (URL: https://www.zslib.com.cn/). This website is an important digital cultural service platform in South China, providing convenient online library service for readers. The website has an intuitive interface design and integrates various functions, extending the service radius of the physical library.

The users of the website are divided into three roles: Tourist, Member and Administrator. Tourists can access to the incomplete collection resources, browse page information and consult online. On the basis of the tourist access, members can access to the complete collection resources, reserve seats and activities, borrow books, read online and enjoy various reader service. Administrators have full access to all functions, including adding, deleting and modifying the website content.

As a comprehensive digital service platform, the website contains many influencing factors. Using the ISM method can effectively sort out the interaction path and hierarchical structure among various factors, which helps to analyze the internal relationship between collection resources, information services and user needs.

This research can not only reveal the operation logic of Sun Yat-sen Library of Guangdong Province website, but also provide scientific decision-making basis for resource integration strategy, service quality optimization and user experience improvement, so as to promote the overall improvement of library service.

4. Interpretative Structural Model of Sun Yat-sen Library of Guangdong Province Website

4.1 Screening of Influencing Factors

The website information architecture was analyzed, and 19 influencing factors were identified and determined, as shown in Table 1.

4.2 Construction of Adjacency Matrix

To determine the interaction between 19 influencing factors, a 19×19 adjacency matrix A was constructed. Based on the relationship network, '1' indicated that the factor had a direct impact on another factor, and '0' indicated that the factor has no direct impact on another factor. According to this rule, the adjacency matrix A was shown in Table 2 to 4.

Table 1. Influencing Factors

Codes	Factors
S_1	Administrator
S_2	Tourist
S_3	Member
S_4	Registration
S_5	Login
S_6	Service Guide
S_7	Resources Accessible by Tourists
S_8	Resources Accessible by Members
S_9	Seat and Activity Reservations
S_{10}	Book Borrowing
S_{11}	Online Reading
S_{12}	Reader Service
S_{13}	Announcement
S_{14}	Event Calendar
S_{15}	Event Reports
S_{16}	New Publications Recommendation
S_{17}	Online Consultation
S_{18}	External Links
S_{19}	Contact Media

Table 2. Adjacency Matrix A-Part 1

	S_1	S_2	S_3	S_4	S_5	S_6	S_7
S_1	0	0	1	1	1	1	1
S_2	0	0	0	1	0	0	1
S_3	0	0	0	0	0	0	1
S_4	0	0	0	0	1	0	0
S_5	0	0	1	0	0	0	0
S_6	0	0	0	0	0	0	0
S_7	0	0	0	0	0	0	0
S_8	0	0	0	0	0	0	0
S_9	0	0	0	0	0	0	0
S_{10}	0	0	0	0	0	0	0
S_{11}	0	0	0	0	0	0	0
S_{12}	0	0	0	0	0	0	0
S_{13}	0	0	0	0	0	0	0
S_{14}	0	0	0	0	0	0	0
S_{15}	0	0	0	0	0	0	0
S_{16}	0	0	0	0	0	0	0
S_{17}	0	0	0	0	0	0	0
S_{18}	0	0	0	0	0	0	0
S_{19}	0	0	0	0	0	0	0

Table 3. Adjacency Matrix A-Part 2

	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}
S_1	1	1	1	1	1	1	1
S_2	0	0	0	0	0	0	0

S_3	1	1	1	1	1	0	0
S_4	0	0	0	0	0	0	0
S_5	0	0	0	0	0	0	0
S_6	0	0	0	0	0	0	0
S_7	0	0	0	0	0	0	0
S_8	0	0	0	0	0	0	0
S_9	0	0	0	0	0	0	0
S_{10}	0	0	0	0	0	0	0
S_{11}	0	0	0	0	0	0	0
S_{12}	0	0	0	0	0	0	0
S_{13}	0	0	0	0	0	0	0
S_{14}	0	0	0	0	0	0	0
S_{15}	0	0	0	0	0	0	0
S_{16}	0	0	0	0	0	0	0
S_{17}	0	0	0	0	0	0	0
S_{18}	0	0	0	0	0	0	0
S_{19}	0	0	0	0	0	0	0

Table 4. Adjacency Matrix A- Part 3

	S_{15}	S_{16}	S_{17}	S_{18}	S_{19}		
S_1	1	1	1	1	1		
S_2	0	0	1	0	0		
S_3	0	0	1	0	0		
S_4	0	0	0	0	0		
S_5	0	0	0	0	0		
S_6	0	0	0	0	0		
S_7	0	0	0	0	0		
S_8	0	0	0	0	0		
S_9	0	0	0	0	0		
S_{10}	0	0	0	0	0		
S_{11}	0	0	0	0	0		
S_{12}	0	0	0	0	0		
S_{13}	0	0	0	0	0		
S_{14}	0	0	0	0	0		
S_{15}	0	0	0	0	0		
S_{16}	0	0	0	0	0		
S_{17}	0	0	0	0	0		
S_{18}	0	0	0	0	0		
S_{19}	0	0	0	0	0		

4.3 Calculation of Reachable Matrix

The adjacency matrix A was added to the unit matrix I of 19×19 (its main diagonal elements were all 1, and the other elements were all 0). Based on the sum of adjacency matrix A and unit matrix I, the reachable matrix M was obtained by further calculation, as shown in Table 5 to 7.

Table 5. Reachable Matrix M-Part 1

	S_1	S_2	S_3	S_4	S_5	S_6	S_7
S_1	1	0	1	1	1	1	1
S_2	0	1	1	1	1	0	1
S_3	0	0	1	0	0	0	1
S_4	0	0	1	1	1	0	1
S_5	0	0	1	0	1	0	1
S_6	0	0	0	0	0	1	0
S_7	0	0	0	0	0	0	1
S_8	0	0	0	0	0	0	0
S_9	0	0	0	0	0	0	0
S_{10}	0	0	0	0	0	0	0
S_{11}	0	0	0	0	0	0	0
S_{12}	0	0	0	0	0	0	0
S_{13}	0	0	0	0	0	0	0
S_{14}	0	0	0	0	0	0	0
S_{15}	0	0	0	0	0	0	0
S_{16}	0	0	0	0	0	0	0
S_{17}	0	0	0	0	0	0	0
S_{18}	0	0	0	0	0	0	0
S_{19}	0	0	0	0	0	0	0

Table 6. Reachable Matrix M-Part 2

	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}
S_1	1	1	1	1	1	1	1
S_2	1	1	1	1	1	0	0
S_3	1	1	1	1	1	0	0
S_4	1	1	1	1	1	0	0
S_5	1	1	1	1	1	0	0
S_6	0	0	0	0	0	0	0
S_7	0	0	0	0	0	0	0
S_8	1	0	0	0	0	0	0
S_9	0	1	0	0	0	0	0
S_{10}	0	0	1	0	0	0	0
S_{11}	0	0	0	1	0	0	0
S_{12}	0	0	0	0	1	0	0
S_{13}	0	0	0	0	0	1	0
S_{14}	0	0	0	0	0	0	1
S_{15}	0	0	0	0	0	0	0
S_{16}	0	0	0	0	0	0	0
S_{17}	0	0	0	0	0	0	0
S_{18}	0	0	0	0	0	0	0
S_{19}	0	0	0	0	0	0	0

Table 7. Reachable Matrix M-Part 3

	S_{15}	S_{16}	S_{17}	S_{18}	S_{19}		
S_1	1	1	1	1	1		
S_2	0	0	1	0	0		
S_3	0	0	1	0	0		
S_4	0	0	1	0	0		
S_5	0	0	1	0	0		
S_6	0	0	0	0	0		
S_7	0	0	0	0	0		
S_8	0	0	0	0	0		
S_9	0	0	0	0	0		
S_{10}	0	0	0	0	0		
S_{11}	0	0	0	0	0		
S_{12}	0	0	0	0	0		
S_{13}	0	0	0	0	0		
S_{14}	0	0	0	0	0		
S_{15}	1	0	0	0	0		
S_{16}	0	1	0	0	0		
S_{17}	0	0	1	0	0		
S_{18}	0	0	0	1	0		
S_{19}	0	0	0	0	1		

4.4 Division of System Hierarchy Structure

The reachable set R(Si), antecedent set A(Si) and intersection C(Si) were determined. The reachable set R(Si) was the set of all factors that can be reached by Si in the reachable matrix or directed graph. The antecedent set A(Si) was the set of all factors that can reach Si in a reachable matrix or a directed graph. The intersection C(Si) was the common part of the reachable set R(Si) and the antecedent set A(Si). The reachable set R(Si), antecedent set A(Si) and intersection C(Si) were shown in Table 8.

According to Table 8, the level division was carried out, and the division rules were as follows: the same factors in the reachable set R(Si) and intersection C(Si) were divided into the first level, and then the factors of this level were removed from the reachable matrix to obtain a new reachable matrix, and its reachable set, antecedent set and intersection were obtained. Then, the division principle of 'reachable set was equal to intersection' was used to find the next level factors, and so on, until the levels of all factors were found, and the complete level division result was obtained, as shown in Table 9.

Table 8. Reachable Set R(S_i), Antecedent Set A(S_i) and Intersection C(S_i)

S_i	R(S_i)	A(S_i)	C(S_i)
1	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19	1	1
2	2,3,4,5,7,8,9,10,11,12,17	2	2
3	3,7,8,9,10,11,12,17	1,2,3,4,5	3
4	3,4,5,7,8,9,10,11,12,17	1,2,4	4
5	3,5,7,8,9,10,11,12,17	1,2,4,5	5
6	6	1,6	6
7	7	1,2,3,4,5,7	7
8	8	1,2,3,4,5,8	8
9	9	1,2,3,4,5,9	9
10	10	1,2,3,4,5,10	10
11	11	1,2,3,4,5,11	11
12	12	1,2,3,4,5,12	12
13	13	1,13	13
14	14	1,14	14
15	15	1,15	15
16	16	1,16	16
17	17	1,2,3,4,5,17	17
18	18	1,18	18
19	19	1,19	19

Table 9. Level Division

Level	S_i
1 (Top)	6,7,8,9,10,11,12,13,14,15,16,17,18,19
2	3
3	5
4	4
5	1,2

4.5 Construction of Interpretative Structural Model

Through matrix calculation and analysis, the interpretative structural model of website information architecture was established. Influencing factors were divided into five levels, as shown in Figure 1.

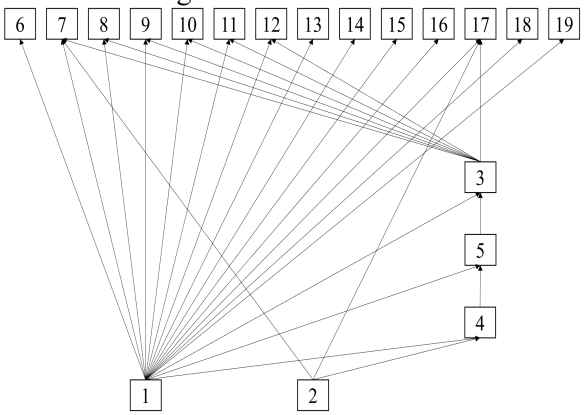

Figure 1. Interpretative Structural Model

The first level factors included: Service Guide, Resources Accessible by Tourists, Resources Accessible by Members, Seat and Activity Reservations, Book Borrowing, Online Reading, Reader Service, Announcement, Event Calendar, Event Reports, New Publications Recommendation, Online Consultation, External Links, Contact Media.

The only second level factor was: Member.

The only third level factor was: Login.

The only fourth level factor was: Registration.

The fifth level factors included: Administrator, Tourist.

4.6 Analysis of Hierarchical Structure

The website adopted a user classification management system and provided users with detailed differentiated service through a clear authority division mechanism. The second, third, and fourth levels were a process of dynamic changes in roles. Tourists can access to the incomplete collection resources, consult online and become members through registration and login. On the basis of tourist access, members can access to the complete collection resources, reserve seats and activities, borrow books, read online and enjoy various reader service. Administrators had complete management authority.

The website adopted a flat information architecture design, which enabled users to quickly understand information and accurately

locate the target service. The influencing factor system presented a five-level hierarchical structure, with the first level containing 14 factors, the second, third and fourth levels each containing 1 factor, and the fifth level containing 2 factors. The flat information architecture design limited navigation to within 5 layers and shortened the information search path. Intuitive navigation was conducive to reducing user's cognitive load in the retrieval process and achieving fast and accurate information acquisition. It was always necessary to find a balance between fully displaying information and avoiding too much information stacking. On the one hand, the website emphasized the core service according to the library business category by setting up separate entrance. On the other hand, the website combined various reader service into one entrance, such as cultural resources database, personal digital library, mobile library, Guangdong local literature catalogue retrieval, book donation, which provided approaches for further use. Considering the interaction between factors, website pages retained links to other related pages. For example, the reader service page contained links to relevant service guide. Association design also reduced cognitive load and helped users quickly obtain the required information. With the help of multi-terminal service, tourists and members were provided with more convenient and rich ways to use library resources.

The analysis results of the interpretative structural model shown that the website information architecture adopted a flat design with distinct hierarchical characteristics and modular layout, and a user classification management system provided clear access for each role of users, which not only ensured the logicality of information organization, but also significantly improved the user experience through flat navigation and accurate classification. The website information architecture was user-centered and tried to achieve a win-win situation of user experience and service efficiency.

5. Opinions and Suggestions

Through online registration, tourists become website members, and can also handle the corresponding library entity card offline. The online and offline scenarios performed unified account management and certification, which improved the management efficiency and user convenience. The online registration entrance was described as handling library card online, which closely corresponded to the offline user scenarios. However, it was not consistent with the conventional habits of internet users and may cause understanding bias. Potential users may considered handling library card online was to prepare for offline access to the library. In general, the advantages of unified account management and certification outweighed the disadvantages. Options that can be considered were to optimize the text representation and UI design of the online registration entrance, or to provide a brief explanation, in order to solve the problem of understanding bias. In addition, online registration application will be reviewed within one business day, rather than got results immediately. Such registration experience still needed to be further optimized compared with conventional internet account registration.

The reader service module integrated resources, service and interaction, with various content items, including cultural resources database, Guangdong local literature catalogue retrieval, personal digital library, mobile library, book donation and so on. The consideration of such classification may be that the use frequency of related items was relatively low, or it was not easy to classify, and therefore integrated into one module. If too many items were integrated into one module, while the internal correlation was not strong, it may affect the efficiency of users to find a specific content entrance. Options that can be considered were to further classify the items of the reader service module. For example, the cultural resources database and Guangdong local literature catalogue retrieval belonged to electronic resources and was suggested to separate from the reader service module and be a separate category or merged with items with similar properties, such as the collection resources.

The library website offered optimized pages for elderly and visually impaired users. Users can switch to pure text mode, adjust the font size and color matching or complete other adjustments, increasing the readability of pages. On the other hand, the website also provided auxiliary voice broadcast service, making it easier for the elderly and visually impaired users to obtain and understand the website information with the help of auditory feedback. The multimodal interaction design broke

through the limitations of conventional website design based on visual communication, and reflected the humanistic care for different user groups. The voice broadcast design still needed optimization. At present, the tone of voice broadcast was rigid, mechanical and lacks real emotions. Under the background that artificial intelligence technology can simulate various human sounds more realistically, the broadcast can be closer to the real person way of speaking by adjusting the speed, tone and volume, so as to improve the user experience of voice broadcast function.

6. Summary

This paper extracted the influencing factors of Sun Yat-sen Library of Guangdong Province website, including user roles, information, resources and service, and used the ISM method to analyze its internal correlation mechanism, which helped to understand and improve the hierarchy and logic of the website information architecture. It also provided a feasible solution for the actual operation optimization of the library website, with both theoretical and practical value.

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