

# Comprehensive Evaluation of Indoor Light Environment in University Archives

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**ABSTRACT:** An index calculation formula of the indoor light environment in university archives was proposed according to five elements of indoor light environment in university archives. The analytic hierarchy process (AHP) was used to calculate the weight of each element. For the specific area of the archives in universities, the analytic hierarchy process can be adopted to result in the value of each element. The value of indoor light environment can be deduced by the weight and value of each element, which can comprehensively evaluate the quality of indoor light environment. Finally the value of indoor light environment in three typical areas was calculated by calculation formula, and the result was similar to investigation survey, which shows the feasibility of this comprehensive evaluation.

**KEYWORDS:** Indoor light environment, University archives, Index calculation formula for the indoor light environment, analytic hierarchy process.

## I. INTRODUCTION

The university archives play an important role in storing, organizing, providing, and transmitting important archives and materials for college teachers and students. As an irreplaceable place in the university, the university archives always stored a large amount of important school archives. When the archivists enter the archives, the indoor light will act on the visual organs to produce vision to help people study and live normally, and at the same time assist the human body to have certain effects on the spirit and emotions, such as cold and warm, light and dark, light and heavy feelings. The comfortable light environment in the archives helps protect the eyesight of indoor personnel, better obtain indoor related information, and create a good reading and working environment for indoor personnel. The poor or inappropriate indoor light environment damages the eyesight of indoor personnel, and may

affect the reading efficiency and effect of indoor personnel.

The indoor light environment of the archives can be defined as the comprehensive lighting range formed by indoor visible light. At present, there is no relevant literature on the light environment of the comprehensive archives of universities. However, due the archives is similar to the library, the light environment of the library is discussed as follows. Liu [1] proposed that the design of library light environment can not only provide good space effects, but also have aesthetic effects. Jiang et al. [2] believe that the requirements of illuminance, uniformity, light color and brightness in different areas of the library are not the same. Therefore, to achieve a high-quality light environment in the library, the illuminance, uniformity, light color and brightness of different areas should be considered comprehensively. Zhang [3] discussed the concept of library design based on the characteristics of the library's light environment and other levels.

For the indoor light environment of an university archives to be built, its illuminance, glare value can be designed in accordance with the "Architectural Lighting Design Standard" (GB 50034-2013). However, for the indoor light environment of the built-up archives, the factors of the indoor light environment are complex. Particularly, some factors cannot even be quantified. There are no reports on the evaluation of indoor light environment in university archives. Thus this article establishes a calculation formula for the indoor light environment in university archives, and calculates the weight value of each index in the formula by the analytic hierarchy process. The evaluation index calculation formula is verified by an example.

## II. INDEX CALCULATION FORMULA OF INDOOR LIGHT ENVIRONMENT

Zhu [4] regards that a comfortable indoor light environment should include 4 elements: appropriate illuminance, appropriate color temperature and color rendering, comfortable brightness ratio, and glare avoidance, respectively.

Wang et al. [5] proposes that a comfortable library indoor light environment should include natural light. Based on the above documents, a comfortable indoor light environment in the archives should have five elements: appropriate illuminance, appropriate color temperature and color rendering, natural light, comfortable brightness ratio, and glare avoidance, as shown in Figure 1.

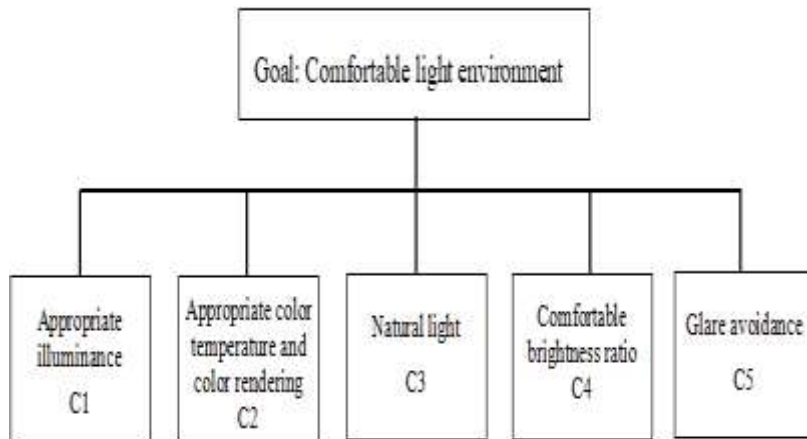


Figure 1. A comfortable indoor light environment in the archives

The index calculation formula of indoor light environment for the archives can be written as[6]:

$$PD = \sum_{i=1}^5 w_i \cdot PD_i \quad (1)$$

Where  $w_i$  is the weight of each sub-indicator. The weight value can be determined by the analytic hierarchy process: authoritative experts judge the relative importance of each main factor, and then calculate the eigenvector corresponding to its largest eigenvalue, and normalize it as the weight of each sub-indicator[7].  $PD_i$  is the evaluation index value of each sub-item, and its value should be determined according to the actual

indoor environment of the archives and also according to the analytic hierarchy process.

The author invited an associate researcher in charge of archives management in the archives of Zhongyuan Institute of Technology, and rated the relative importance of the above five main factors according to the Saaty nine-level scale [8]. The results of the relative importance rating are shown in the table. 1. Table 1 also lists the eigenvector corresponding to the normalized maximum eigenvalue, that is, the weight of each sub-item evaluation value. Therefore, formula (1) is rewritten as the following formula:

$$PD = 0.51 \times PD_1 + 0.22 \times PD_2 + 0.1 \times PD_3 + 0.06 \times PD_4 + 0.04 \times PD_5 \quad (2)$$

**Table 1** The main influencing factors and calculated weights of the indoor light environment in the archives

	C1	C2	C3	C4	C5	Calculated weight
C1	1	5	6	7	8	0.58
C2	1/5	1	3	5	6	0.22
C3	1/6	1/3	1	2	3	0.10
C4	1/7	1/5	1/2	1	2	0.06
C5	1/8	1/6	1/3	1/2	1	0.04

Where  $PD_1, PD_2, PD_3, PD_4$  and  $PD_5$  represent the index values of appropriate illuminance, appropriate color temperature and

color rendering, natural light, comfortable brightness ratio, and glare avoidance, respectively. In particular, the  $C.I.$  of the analytic hierarchy process is  $0.0623 < 0.1$ , which indicates

that the consistency of the calculation is acceptable, that is, the calculated weight value is true, valid and acceptable.

### III. EXAMPLE

From the spatial layout, comprehensive archives can generally be divided into reading rooms, offices, warehouses. The indoor light environment requirements of each area are different, and the final indoor light environment is also quite different. The three typical areas of the archives of Zhongyuan Institute of Technology are chosen here, and the indoor light environment of these three typical areas is evaluated according to formula (2).

The calculation of the index value is similar to the calculation of the weight value. First, an associate researcher from the archives of Zhongyuan Institute of Technology is invited to rate the relative importance of each type of index in the three typical regions, and then the eigenvector corresponding to the largest eigenvalue of the matrix is calculated. The normalized eigenvector is the index value of this type of index. The calculation results are shown in Table 2, which not only shows the index values of each type of index in the three typical areas, but also calculates the final indoor light environment values of the three typical areas according to formula (2).

**Table 2** Index value and light environment index of index in three typical areas

	C1 ( 0.58)	C2 ( 0.22)	C3 ( 0.10)	C4 ( 0.06)	C5 ( 0.04)	Light environment index
Reading room	0.73	0.61	0.32	0.73	0.65	0.66
Office	0.19	0.24	0.57	0.1	0.12	0.23
Warehouse	0.08	0.15	0.11	0.17	0.23	0.11

It can be seen from Table 2 that the indoor light environment values of the reading room, office and warehouse are 0.66, 0.23 and 0.11 respectively. The result shows that among the selected three typical areas, the indoor light environment of the reading room is the best, and the indoor light environment of the warehouse is the worst.

One hundred teachers and students were chosen to be surveyed, and they all agreed with the conclusion, i.e., the indoor light environment in the three typical areas, from good to bad, were the reading room, office and warehouse. The survey shows that the survey value is basically close to the calculated value, indicating that the evaluation system is true and credible. This conclusion is also consistent with the requirements of the indoor light environment in the literature [1].

### IV. CONCLUSION

An index calculation formula of the indoor light environment in university archives is proposed. The conclusions are as follows:

(1) A calculation formula for the indoor light environment of a comprehensive archives is proposed. The calculation formula includes five

sub-indices for a comfortable indoor light environment: appropriate illuminance, appropriate color temperature and color rendering, natural light, comfortable brightness ratio, and glare avoidance,.

(2) The analytic hierarchy process is used to calculate the weight values of the five sub-indices in the indoor light environment calculation formula. The weights of appropriate illuminance, appropriate color temperature and color rendering, natural light, comfortable brightness ratio, and glare avoidance are: 0.58, 0.22, 0.10, 0.06, 0.04.

(3) Three typical areas of Zhongyuan Institute of Technology archives, reading room, office and warehouse were selected, and the index values of each type of index in the three areas were calculated, and then the three typical regional light environment indexes were calculated as: 0.66, 0.23 and 0.11. It shows that the order of light environment quality from good to bad is: reading room, office and warehouse. The survey shows that the calculated value is basically close to the survey value, indicating that the evaluation system is true and credible.

### REFERENCES

- [1]. Liu, X., 2016, "Research on light environment in library space design," *Grand View of Fine Arts*, 10, 112-113.
- [2]. Jiang, X.; Liu, Y., 2003, "Requirements and realization of the architectural light environment of modern libraries," *Library Journal*, 22 (8): 27-29.
- [3]. Zhang, X., 2014, "The space design and light environment design of the library," *Library*, 4, 140-143.
- [4]. Wang X.; Zhou B., 2010, "Mathematical Modeling and Mathematical Experiment," Beijing: Science Press.
- [5]. Wang Q.; Liang W., 2009, "Design of library interior light environment," *Library Work and Research*, 160 (6): 101-102
- [6]. Zhang J., 2004, "Comprehensive evaluation of library indoor environment," *Journal of Chengdu University*, 23 (3): 44-49.
- [7]. Li J., 2014, "An Empirical Study on the Impact of Incentive Mechanism on Employees' Satisfaction in Textile Enterprises," Master's Thesis of Zhongyuan Institute of Technology.
- [8]. Zhu Y., 2020, "Architecture Environment," Beijing: China Construction Industry Press.