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Evaluating Academic Book Impact Using Weighted TOPSIS Method (Postprint)

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Abstract

[Purpose/Significance] Addressing the current environment of academic book evaluation, this study explores the feasibility of establishing a comprehensive evaluation framework for academic books using the TOPSIS method, and provides a novel approach and methodology for comprehensive evaluation of academic books.

[Method/Process] First, highly-cited academic books in the field of library and information science are selected as research subjects, and a comprehensive evaluation indicator system is constructed by combining high-frequency indicator screening with the coefficient of variation method. Second, the CRITIC method is utilized to calculate indicator weight values. Finally, the weighted TOPSIS method is employed to conduct empirical analysis on the sample books and obtain a comprehensive ranking of their influence.

[Results/Conclusion] Through analysis of the results, it is found that the comprehensive evaluation method combining the CRITIC method with weighted TOPSIS expands the limitations of current academic book evaluation methods, demonstrates stronger operability, and yields more reasonable results, thereby providing a comprehensive evaluation methodology for academic books that integrates both qualitative and quantitative considerations.

Full Text

Preamble

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Research on the Evaluation Method of Academic Book Influence Using Weighted TOPSIS Method

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Abstract

[**Purpose/Significance**] In view of the current academic book evaluation environment, this paper discusses the feasibility of establishing a comprehensive evaluation of academic books using the TOPSIS method, and provides a new idea and method for comprehensive evaluation of academic books. [**Method/Process**] Firstly, highly-cited academic books in the field of library and information science are selected as the research object, and a comprehensive evaluation index system is constructed by combining high-frequency index screening and coefficient of variation methods. Secondly, the CRITIC method is used to calculate index weights. Finally, the weighted TOPSIS method is applied to conduct empirical analysis on sample books and obtain a comprehensive ranking of influence. [**Result/Conclusion**] Through analysis of the results, it is found that the comprehensive evaluation method combining the CRITIC method and weighted TOPSIS expands the singularity of current academic book evaluation methods, is more operable, and yields more reasonable results, providing a comprehensive evaluation method for academic book evaluation that considers both qualitative and quantitative aspects.

Keywords: academic book; influence evaluation; TOPSIS method
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Academic evaluation is an indispensable part of scientific research. It not only improves the efficiency of knowledge exchange and reveals the value of academic achievements, but also plays an important guiding role in scientific research development. Academic evaluation involves the assessment of a series of scientific research outputs including academic papers, journals, books, and research reports, and the results of academic evaluation often constitute important factors affecting researchers' learning, communication, and career development. As systematic knowledge outputs, academic books should be evaluated with particular caution. In recent years, the book publishing industry has been in a state of steady development, with the number of published books increasing year by year. According to the 2016 China Publishing Yearbook Report [1], the number of book titles published nationwide in 2016 reached 500,000, an increase of 5.1% compared with 2015. Although academic books account for only a portion of this total, conducting academic book evaluation has become an urgent task. However, research on academic book evaluation in China is relatively scarce, with the first Chinese academic book citation index tool only officially released in 2015. In view of this, this study intends to construct a multi-level academic book evaluation index system from an empirical analysis perspective, using multivariate statistical analysis methods to conduct comprehensive evaluation of academic books, in order to provide reference for the application of academic book evaluation in China and fill the current research gap.

1 Research Status of Academic Book Evaluation

1.1 Foreign Research Status

In terms of book evaluation methods, foreign researchers mainly focus on citation analysis and altmetrics-based analysis methods [2-5]. M. Thelwall et al. conducted citation analysis on 2,739 academic monographs published on Amazon in 2008 and 1,305 bestsellers in academic categories on Amazon, finding that online book reviews often reflect a book's popularity rather than academic impact, suggesting that online reviews should be used to evaluate books aimed at broad audiences both inside and outside academia [2]. A. Abrizah et al. used Google Books and Google Scholar to extract 1,357 academic books published by five Malaysian university presses between 1961 and 2012 for citation evaluation, finding that global citation databases also cover non-Western books [3], but the sample was relatively thin and insufficiently persuasive. M. Thelwall and K. Kousha compared academic book evaluation indicators on the social networking site Goodreads with other book evaluation indicators, finding that reader feedback on Goodreads can reflect multiple dimensions of book influence, and that informal readers can also help assess book influence [4]; however, Goodreads only includes slightly more than 10,000 books, which is insufficient to demonstrate the feasibility of the conclusion.

In addition, some relatively mature evaluation tools have been developed abroad. For example, the Book Citation Index (BKCI) released by Thomson Reuters in October 2011 is a book citation index platform that includes strictly selected academic books, currently comprising more than 70,000 academic books published since 2005, with 10,000 titles added annually. Through tracking and analysis, it can clearly present the citation situation of books and their positions in citation networks [6]. In 2013, the Scopus abstract and citation database also began to include academic books such as monographs, textbooks, and series, similarly providing academic book citation index functions [7]. Furthermore, Scopus's ArticleMetrics indicators also introduced altmetrics indicators to evaluate the influence of academic books in the network environment from four aspects: academic activities, social activities, academic reviews, and mass media. In 2015, Springer collaborated with Altmetric.com to develop the Bookmetrix platform [7] to evaluate books from the perspective of altmetrics. The Bookmetrix database references five types of indicators: book citations, online mentions, readers, reviews, and downloads, fully considering book influence and visibility.

1.2 Domestic Research Status

Chinese scholars and experts mainly focus on analyzing academic book evaluation model methods and the current state of evaluation work [8-11]. For example, Ren Hongjuan conducted a review study on Chinese book evaluation methods, concluding that establishing a more complete and objective index system is the way forward for book evaluation [8]. Zhang Yanli also reviewed

research on academic book quality evaluation methods and indicators, and proposed suggestions for improving academic book quality evaluation [9]. Wang Lanjing and Ye Jiyuan analyzed the bottleneck factors in the evaluation of Chinese humanities and social science academic books, pointing out that constructing an innovation and quality-oriented evaluation system for humanities and social science academic books helps improve the overall quality of academic book publishing and is of great significance for future social science development [10]. Yuan Hui used content analysis and comparative research methods to compare academic book reviews from Chongqing University Library's self-built review system with Douban reviews, exploring how to improve review utilization and constructing structured reviews to promote better use of reviews for academic book promotion [11]. Some scholars have conducted empirical evaluations of academic books using quantitative methods. For example, Zhang Yu et al. constructed a Chinese scientific book academic influence evaluation system from a multi-dimensional perspective, conducted empirical research on medical books using hierarchical analysis and weighted comprehensive evaluation methods, and proved the effectiveness of the method [12]. Some scholars have attempted to evaluate foreign academic books. For instance, Kuang Denghui used the Bookmetrix tool to study chemistry and social science academic e-books using a combination of altmetrics and citation analysis [13]; however, this study mainly used existing foreign tools to evaluate academic e-books, and the limited scope of e-books cannot represent all academic books, making the study limited. Xiong Xia et al. explored evaluation methods for foreign e-books based on three platforms—BKCI, Scopus ArticleMetrics, and Bookmetrix—and conducted empirical analysis using Southwest Jiaotong University as a case [7], but the study lacked depth and only analyzed the advantages and disadvantages of the three platforms. Some scholars have also constructed new evaluation index systems for academic books. For example, Lei Shuyi et al. conducted a systematic study on academic book evaluation from an altmetrics perspective, finding that introducing altmetrics indicators can provide a new perspective for domestic Chinese academic book evaluation [14]. Li Ming et al. also introduced altmetrics indicators into academic book evaluation [15], but only established the indicators without further analysis of how to construct an altmetrics-based academic book evaluation system. He Jun et al. established a comprehensive Chinese book evaluation system using methods such as the analytic hierarchy process, constructing indicators through a combination of qualitative and quantitative methods, and proved the method's feasibility through empirical analysis [16]; the evaluation system was relatively comprehensive but required further refinement of indicators for different types of books.

In terms of evaluation tools, the most representative domestic tools are the Chinese Book Citation Index (CBKCI) and the China Highly-Cited Books Annual Report. The Chinese Book Citation Index (CBKCI), established in 2013 by Nanjing University and the Chinese Social Sciences Research Evaluation Center, includes humanities and social science academic books published by nearly 600 publishers, evaluating academic book quality and influence through citation

data [17]. In January 2017, the China Scientific Literature Metrology Evaluation Research Center officially released the 2016 edition of the China Highly-Cited Books Annual Report [18], which is based on book bibliographies officially published since the founding of the People's Republic of China (approximately 4.22 million titles) and selects more than 70,000 highly-cited books based on citations in Chinese academic journal papers, doctoral and master's theses, and conference papers in the CNKI database over the past three years. It is China's first comprehensive and objective tool for evaluating book academic influence, filling the gap in quantitative evaluation of book academic level. In summary, existing research either reviews the current state of book evaluation or explores from the perspective of citation analysis and other methods, but overall research remains relatively scarce, with unclear evaluation objects, relatively chaotic evaluation indicators, and evaluation methods that need improvement. Moreover, academic book evaluation requires not only objective and complete indicators and scientific and reasonable methods, but also a clear definition of academic books. Constructing indicators from the perspective of academic books helps establish a more complete evaluation system and creates a better environment for the future development of academic books in China.

2 Evaluation Index Construction

Existing research on academic book evaluation indicators is mostly based on citation analysis, with chaotic and unrepresentative indicators. This study draws on previous research, referring to authoritative academic book evaluation tools (CBKCI and China Highly-Cited Books Annual Report) and indicator systems constructed by scholars (specifically those mentioned in the domestic research status section above), and screens out more reasonable and representative indicators through frequency analysis and coefficient of variation methods. Frequency analysis can select frequently cited indicators and delete less discussed ones, while coefficient of variation screens indicators with the greatest information discrimination power from an objective perspective, best representing data information.

(1) Frequency Analysis-Based Indicator Screening Method. By analyzing existing academic book evaluation indicators, a three-level indicator system combining comprehensive qualitative and quantitative evaluation indicators is listed, including four dimensions: book reputation, book citation, book evaluation, and book utilization, comprehensively covering all aspects of academic book evaluation from publication to utilization. After frequency analysis, indicators with low usage frequency and duplicate indicators are deleted. Meanwhile, since book sales volume is difficult to obtain and measure, and available sales data is also questionable, this study does not use book sales as an evaluation indicator. The initial indicators for academic book influence evaluation are thus obtained, as shown in Table 1 .

(2) Coefficient of Variation-Based Indicator Screening Method. The coefficient of variation method uses the coefficient of variation of variables to de-

scribe their information discrimination power. Indicators with larger coefficients of variation have the strongest information discrimination power and the most obvious effect on evaluation results, while those with smaller coefficients have weaker discrimination power. Here, the coefficient of variation dj is calculated for each indicator to describe its discrimination power (indicator data acquisition and coefficient of variation calculation methods will be detailed later). The calculation results of each indicator's coefficient of variation are shown in Table 1 above. Based on the results, indicators with larger coefficients of variation are retained, and five indicators with coefficients of variation below 2 are deleted. The final academic book influence evaluation index system consists of 4 first-level indicators, 8 second-level indicators, and 13 third-level indicators, as shown in Table 2 .

3 Evaluation Methods

3.1 CRITIC Weighting Method

This study uses the CRITIC method to determine indicator weights. The CRITIC method, proposed by D. Diakoulaki [19], is a method for determining indicator weights based on the contrast intensity and conflict between indicators, which better reflects objective data information. The specific calculation steps are as follows:

(1) The contrast intensity between indicators is represented by standard deviation. Since the standard deviations between indicators differ greatly, the coefficient of variation is used here instead, where dj represents the coefficient of variation of the j-th indicator and σj represents the standard deviation.

(2) Indicator conflict is represented by inter-indicator correlation. If two indicators have a strong positive correlation, it indicates low conflict between them, where Cj represents the correlation coefficient between the j-th indicator and the k-th indicator, and $r$jk represents the conflict between the j-th indicator and other indicators.

Cj = Σk=1n(1 - $r$jk)

(3) Indicator weight calculation. Ij represents the information quantity of the j-th indicator, and Wj represents the weight of the j-th indicator.

Ij = dj * Cj

Wj = Ij / Σk=1n Ik

3.2 Weighted TOPSIS Method

The TOPSIS method, proposed by C.L. Hwang and K. Yoon, is a method for ranking a limited number of evaluation objects according to their proximity to an idealized target. It is a comparative evaluation of relative advantages and

disadvantages among existing objects. TOPSIS is a commonly used method in multi-objective decision-making that ranks evaluation targets by approximating the ideal solution. Its basic principle is to calculate the optimal and worst solutions for evaluation objects and rank them by comparing their relative closeness to these solutions. The evaluation of academic book influence in this study is a type of multi-attribute decision-making problem, making this method reasonable. The specific calculation steps are as follows:

(1) Establish a standardized data matrix. To eliminate dimensional effects, the initial data matrix is normalized to obtain the standardized data matrix Zij.

(2) Construct the weighted matrix Z ij, where Wj is the weight of each indicator obtained above.

Z ij = Wj * Zij, (i = 1, 2, …, m, j = 1, 2, …, n)

(3) Calculate the positive ideal solution X+j and negative ideal solution X-j of the weighted matrix Z ij.

X+j = maxi(Z ij), (j = 1, 2, …, n)
X-j = mini(Z ij), (j = 1, 2, …, n)

(4) Calculate the distances d+i and d-i from each evaluation object to the positive ideal solution X+j and negative ideal solution X-j.

d+i = Σj=1n(Z ij - X+j)2, (i = 1, 2, …, m, j = 1, 2, …, n)
d-i = Σj=1n(Z ij - X-j)2, (i = 1, 2, …, m)

(5) Determine the relative closeness fi of each evaluation object to the optimal and worst values. The relative closeness ranges from 0 to 1; the closer to 1, the higher the evaluation grade and the higher the ranking.

fi = d-i / (d+i + d-i)

4 Empirical Analysis

4.1 Data Acquisition

This study focuses on Chinese academic books, selecting the China Citation Database as the data source. The research objects are selected from reader services (category G252) in library science and library affairs (category G25) of the fourth edition of the Chinese Library Classification (CLC). Library science and library affairs are more closely related to this research direction, and books in the reader services category have higher utilization rates. Therefore, academic books cited under CLC category G252 (reader services) in the fourth edition of CLC are selected. The retrieval scope includes journal databases, dissertation databases, and conference paper databases, with cited document type as books, publication years 2011-2015, and citation years 2011-2018. According to Ye Jiyuan's definition of academic books [20], which includes academic works, academic monographs, academic paper compilations/textbooks, and reference

books that are innovative and valuable for learning and research, the books cited by journals, dissertations, and conference papers can exactly cover these categories, making the China Citation Database a reasonable choice.

Through the above retrieval conditions, 245 bibliographic records were obtained. Indicator data for these 245 records were retrieved, as shown in Table 3 . Most indicators can be directly retrieved through web queries, while authors' average annual publication count, average citations per paper, and funded publication volume were retrieved from CNKI. Since G252 belongs to humanities and social science books, the data obtained from CNKI can already represent most authors. The award status indicator includes books that have won the China Excellent Publications Award, China Publishing Government Award, and the "Five Ones Project" Award. Book edition and printing information can be queried through the book's CIP number.

4.2 Data Standardization

The 245 indicator data records were cleaned by deleting books authored by collective organizations, books with unsearchable indicator data, and a very small number of English books, leaving 205 records as the final research objects. To eliminate dimensions from these 205 indicator data records, range standardization was used for data normalization to obtain the standardized data matrix Zij, as shown in Table 3 (due to space limitations, only partial samples and partial indicators are displayed). The formula is as follows:

Zij = (Xij - Xminj) / (Xmaxj - Xminj), (i = 1, 2, ..., m, j = 1, 2, ..., n)

4.3 Data Processing

(1) **Indicator Weight Calculation.** According to the CRITIC weighting method in Section 3.1 above, the weights of the 13 indicators were obtained.

ω = (0.1106, 0.0588, 0.0935, 0.0718, 0.0674, 0.1403, 0.0652, 0.0730, 0.1292, 0.0479, 0.0458, 0.0461, 0.0504)

(2) **Construct Weighted Data Matrix.** The weighted data matrix Z ij is obtained by multiplying the original data matrix Zij by the weight vector ω.

(3) **Positive and Negative Ideal Solution Calculation.** The positive and negative ideal solutions are obtained from the weighted data matrix Z ij.

X+j = (1.0903, 0.0588, 0.0935, 0.0861, 0.0673, 0.1403, 0.0652, 0.0730, 0.1292, 0.0479, 0.0458, 0.0461, 0.0504)
X-j = (0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0)

(4) **Distance Calculation from Evaluation Objects to Positive and Negative Ideal Solutions.** The distances d+i and d-i from each evalua-

tion object to the positive and negative ideal solutions are obtained using the above calculation method, with results shown in Table 4 .

(5) **Final Ranking of Academic Book Influence.** The relative closeness fi of the 205 samples to the optimal and worst solutions is calculated using the above formula, with results shown in Table 4. Table 5 shows the top 10 books ranked by academic book influence calculated using the method in this paper.

4.4 Result Analysis

Comparing the academic book ranking results calculated by citation frequency in Table 4 with the ranking results calculated by the CRITIC and weighted TOPSIS method in Table 5, significant differences are found. Books with high citation frequency do not necessarily have the highest collection volume, reader discussion level, or utilization rate. Books with high citation frequency in CNKI are mainly academic monographs with strong professionalism and innovation, whose content is more in-depth than ordinary academic books, thus receiving more citations. In contrast, general academic books such as textbooks, reference books, or academic essays are easier to understand, and their universal readability enables wider dissemination, correspondingly increasing online discussion, collection volume, and publication editions. In general, the academic nature of academic books does not conflict with their influence. Books with strong academic nature, such as academic monographs, represent more in-depth research and stronger innovation, and can perform better in specific professional fields, but correspondingly have a more limited readership and restricted dissemination. Textbooks and reference books, although also called academic books, may not be as professional as monographs, but have a broader audience than academic monographs, and their academic value can be reflected among the audience, making them also commendable academic books.

This study obtained 205 cited academic books in the field of library science from the China Citation Database, established an influence evaluation index system suitable for Chinese academic books by combining existing research on academic book evaluation indicators, and calculated comprehensive evaluation values using the combination of CRITIC weighting method and weighted TOPSIS, proving the feasibility of the method. The weighted TOPSIS method can fully reflect original data information but cannot obtain weights. Therefore, the CRITIC weighting method was selected from an objective perspective to obtain indicator weights, which is more scientific and reasonable than using the analytic hierarchy process or expert consultation alone. Compared with time-consuming and labor-intensive book reviews, this method has strong operability and practicality. In future research, this method can be extended to the evaluation of academic books in other fields, making the overall evaluation of academic books more convenient and feasible. In addition, this method promotes the development of book evaluation research in China and advances subsequent in-depth research on book evaluation methods.

This study also has some limitations. Due to the difficulty in obtaining some indicator data, such as total book sales volume—given that current book sales channels are divided into online and offline platforms involving multiple platforms, and available sales data lacks authenticity—incorporating such data into the analysis would inevitably cause result bias and affect the entire study. The lack of some data sources will also lead to inaccurate evaluation results. In addition, simply recording the number and star rating of reviews for each book cannot fully reflect readers' likes and dislikes. This study only considered author reputation and publisher reputation in terms of book reputation, lacking editorial feedback. Future research directions could consider introducing more dimensional indicators, using data crawling methods to obtain more comprehensive data, and employing reader sentiment mining methods to evaluate books.

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Author Contributions

Wang Luona: Topic formulation, data collection and processing, and paper writing;
Li Duanming: Paper guidance.

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Keywords: academic book; influence evaluation; TOPSIS method

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