Assessment Method on the Utilization Benefit of Academic Electronic Databases in University Library Based on Outcomes of Scientific Researches

Guihua Li*, Li YANG

Yunnan Normal University, Library of Chenggong Campus, Kunming, China

*corresponding author

Keywords: University library, Academic electronic database, Utilization benefit for academic research, Assessment method, Case study

Abstract: The purpose of purchasing electronic databases (EDBs) in university libraries is to meet the needs of discipline construction and academic researches. Therefore, the quantified outcome of a scientific research is an indirect indication of the utilization benefit (UB) of an EDB for the academic purpose (AP). In this article, an assessment method on the UB of EDBs for academic activities is proposed with the quantitative outcome of academic researches as the first-level indication, the dependence degrees of acquisition of an achievement on all related EDBs and a specific EDB as the second- and third-level indications, respectively. To examine the feasibility of the method proposed in this work, a case study is conducted based on the detailed data of academic achievements in 2019 provided by Yunnan Normal University and a questionnaire survey about the use of five typical EDBs in the library for funding projects, research papers, academic books and other academic activities. The results show that the CNKI is the best, followed by Elsevier SD, and Superstar Books worst in terms of annual UB of a single EDB for AP.

1. Introduction

Library resources are the core resources of university libraries, and it is the basis of shaping and defining library. University library resources include physical resources and network electronic resources. Electronic resources gradually get the reader's approval due to their wider source, easy to obtain, spread, download and carry, be convenient for reading at anytime and anyplace. In recent years, with the rapid development of communication and network technologies, university libraries begin to shift the focus of library resources construction to electronic resources construction [1, 2]. It was reported that the investment of funds on print library resources in Sichuan University took about 62% of the total investment in 2008. However, the situation was reversed in 2017 that the funds for print library resources accounted for 32%, but the funds for electronic resources took about 68% of the total expenditure [3]. Compared with 2015, the amount of print books borrowed in Yunnan Normal University dropped 45% in 2019, but e-book downloads increased by 125 times [4]. To meet the needs of discipline construction, scientific research and teaching, local universities invest a lot of funds to purchase relevant electronic databases (EDBs) every year. However, it is found that the utilization of EDBs purchased is lower, the waste of resources is higher, and the cost of acquiring literatures and information is high [2, 4]. An investigation by Zhou showed that the users of electronic resources in universities were mainly teachers, graduates and senior undergraduates, and purposes of using electronic resources were usually for academic researches and dissertations [5]. The previous investigation of authors found that all universities in Yunnan have purchased a certain number of Chinese and foreign language EDBs, but ordinary and vocational colleges rarely purchased or built their own EDBs [4]. These findings indicate that the objective of purchasing EDBs in colleges and universities is basically to meet the needs of discipline construction and academic researches. However, whether the investment of funds is proportional to the utilization rate of resources, and whether the allocation of electronic resources conforms to the discipline construction and development of the school has become the most concern about the construction and management of electronic resources in universities.

The benefit of EDBs includes the acquisition cost (AC) of literatures and information and the

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utilization benefit (UB) produced by using EDBs. The former depends on the number of users and utilization rate of resources, whereas the later depends on the purpose of resources use. University libraries generally pay for the use of a database in a package instead of paying based on the actual use, thus the more times a database is used, the lower the AC. The UB of a database for academic purpose (AP) is generally dependent on the AC but not proportional to the AC. Although the AC is high for some professional EDBs, the information and literatures provided are of great value to the relevant academic researches [6]. The main purpose of purchasing EDBs in university library is to meet the needs of academic researches, graduate training and undergraduate dissertations, while graduate training on the ability of scientific researches and undergraduate dissertations also belong to academic researches. Therefore, the quantified outcome of scientific and technological researches in universities is the indirect indication of the UB of EDBs for AP, but the correlation degree between the acquisition of scientific and technological achievements (STAs) and the use of EDBs differs for different types of STAs. The acquisition of some STAs is highly dependent on the support of literature and information of EDBs, while others less or not. In principle, the assessment method on the UB of EDBs for AP in universities based on the quantified STAs accords with the original intention of purchasing EDBs in university libraries and is a more reasonable method. The premise to perform such assessment is to establish a reasonable and feasible quantitative assessment method of STAs first, and then to determine the correlation coefficients between a quantified STA and the UB of all relevant EDBs and each of related EDBs. In recent years, many researchers have tried to construct such assessment methods of the UB of EDBs for AP with the quantitative STAs as the first level indicators, but they almost have failed to practical applications as the first level indicator is hardly to be quantitatively determined [6-8] due to the noticeable difference in types of STAs.

In recent years, to encourage teachers to complete high-level and high-quality STAs and improve the academic reputation and status of universities, many universities have proposed a perfect quantitative assessment method of the STAs, and the quantified STAs are commonly used as the basis for teachers' post examination and distribution of annual award granted for academic researches. Thanks to the establishment of perfect quantitative assessment methods on STAs, makes it possible to quantify the UB of EDBs in university libraries. In this article, taking Yunnan Normal University as a case study, a method to assess the UB of EDBs for AP in universities is proposed with the quantified STAs as the first level indicators, dependency degree between acquisition of STAs and the use of EDBs as the second level indicator, and the contribution weights of related EDBs to the acquisition of STAs as the third level indicator. The objective of this work is to propose a feasible quantitative assessment method on the UB of EDBs purchased by university libraries, and expect its practical application.

2. Correlation between Acquisition of Stas and the Use of Edbs

2.1 The Connotation of Ub of Academic Edbs

The process of academic research is a process of constantly exploring the unsolved mysteries in science and technology. As a scientific and technological worker, it is necessary to promptly understand the latest research trends, cutting-edge academic and technical problems, revealed and yet-unrevealed academic issues in the field, and the latest information and progress about these issues are commonly reported in academic journals or conference proceedings. Thanks to highly-developed electronic and communications technologies in recent years, most of these literatures and information are included in various EDBs, and users can obtain the required literatures and information through internet by purchasing the right to access the EDBs. Similarly, researchers over the world can share and exchange their latest research findings fed to EDBs each other. The purpose of purchasing academic EDBs in universities is to mainly meet the needs of scientific and technological personnel for acquiring relevant literatures and information to assist their academic researches. Therefore, the UB of EDBs in university libraries is represented by academic values of

STAs. In other words, the academic value of STAs is the indirect indication of the UB of EDBs.

2.2 Identification of Quantitative Indication of Stas

Strictly speaking, because of the difference in discipline and category of achievements, the academic value of STAs is not comparable each other, and the true value of some STAs in history is recognized by people after many years. To facilitate quantifying STAs, universities and research institutions in our country usually assess the academic value of a STA according to the academic or social influence of the media or institutions where the STA is issued or published. However, there are great differences in the level of running universities and discipline structure, an university usually proposes a quantitative assessment method of STAs acceptable for most staffs according to its own scientific research practice, and results obtained based such assessment method will be used as the basis for teachers' post examination and distribution of annual award granted for academic researches. In 2019, Yunnan Normal University issued an updated version of assessment method of STAs. The method includes the identification and quantification of funded projects, academic papers and books, advisory reports, art works and intellectual property, etc. Table 1 presents the detailed rule for the identification and scores of academic papers in natural science. To save space, rules for the identification of other STAs in this method are not presented.

Table 1 Rule for Identification and Score of Academic Papers in Natural Science (I_1)

Level		Scope	Score
A	A1	Articles published in NATURE and SCIENCE	100
	A2	Letter published in NATURE, Report and Reviews in SCIENCE	80
	A3	Other articles or works in NATURE and SCIENCE, and indexed by SCIE	70
B	B1	Articles in journals of JCR-1 and indexed by SCIE	50
	B2	Articles in journals of JCR-2 and indexed by SCIE	40
	B3	Articles in journals of JCR-3 and indexed by SCIE	30
	B4	Articles in journals of JCR-4 and those indexed by EI	25
C	C1	Articles in journals included in CSCD	20
	C2	Articles in journals included in CSCD expended, in conference proceedings and indexed by CPCI-S or EI	15
D	D1	Articles in core journals recognized by library of Beijing university	15
	D2	Articles in journal of Yunnan Normal University (natural edition)	10
E	E1	Articles in journals indexed by CNKI	5
	E2	Articles published in conference proceedings	3
		Articles in provincial level of newspapers or journals(>2000 words)	
		Papers and comments in special and additional edition of all other journals	

Table 2 Correlation Coefficient Between the Acquisition of a Sta and the Use of Edbs

Degree of dependence	identification criteria	I_2
High dependence	Essential and critical literature and information provided for the achievement	0.7-1
Moderate dependence	A great number of references and information provided for the achievement	0.4-0.7
Low dependence	A certain amount of literatures or information provided for the achievement, but not necessary for the achievement	0-0.4

2.3 Assessment on Quantitative Indications of Ub of Edbs

The quantitative academic value of STAs in terms of score is the indirect indication of UB of EDBs for AP, so it can be regarded as the first level indicator of the UB of EDBs (I_1), but it is not equivalent to UB as the acquisition of ASTs benefits from a wide range of literature and information support. In addition to EDBs, there are also print books, other online electronic resources, etc. Therefore, in the quantitative assessment on UB of EDBs, it is necessary to confirm that dependency degree of the acquisition of STAs on the use of EDBs, namely correlation coefficient between a quantified STA and the use of EDBs (I_2) purchased by the library. I_2 as the

second level indicator of UB of EDBs can be identified based on the dependency degree of a STA on EDBs during the acquisition of the STA and quantitatively identified by owners of the STA at the time when they report to the university. To ensure that the identification of I_2 is fair and reasonable, library and achievement recognition department of the university should formulate a unified identification criterion for different types of STAs, and also can refer to the identification criteria listed in Table 2.

2.4 Assessment on Ub of Edbs for Ap

According to the definition of I_2, the annual UB of EDBs for AP can be estimated by:

$$M=\sum_{n} I_{1,i} I_{2,i} \quad (1)$$

where *n* is the total number of STAs acquired by the university in a year, $I_{1,i}$ is the score of identified i^{th} achievement, and $I_{2,i}$ is the correlation indicator between the acquisition of i^{th} achievement and the use of EDBs. The UB of EDBs for unit capital investment is expressed by:

$$m=M/C \quad (2)$$

where C is the annual capital investment on EDBs, including the purchase, maintenance and operation costs of EDBs. Libraries usually purchase many EDBs to meet the academic research needs of different disciplines, and the acquisition of a STA only requires to use literatures and information from one or several EDBs. To assess the UB of various EDB for AP, it is necessary to assess the UB of a single EDB. The UB of a single EDB in a year is estimated by:

$$M_k=\sum_{n} I_{1,i} I_{2,i} I_{3,i}^{k} \quad (3)$$

where $I_{3,i}^{k}$ is the index of UB contributed by k^{th} EDB for the acquisition of i^{th} STA, which is regarded as third level indicator of UB of EDBs. For all EDBs relevant to the acquisition of i^{th} STA, the $I_{3,i}^{k}$ of them are subjected to:

$$\sum_{j} I_{3,i}^{k} =1 \quad (4)$$

where j is the number of EDBs relevant to the acquisition of i^{th} STA, and UB of a single EDB for unit capacity investment in a year can be estimated by:

$$mk=Mk/Ck \quad (5)$$

The C_k in the above expression represents the annual capital investment on the k^{th} EDB.

Table 3 First- And Second-Level Indicators of Dissertations for Assessing Ub of Edbs

	Ph. D	Master	Bachelor
I_1	30	15	5
I_2	0.7	0.7	0.8

Table 4 Third-Level Indicator of Dissertations in Science and Technology

Database	Ph. D	Master	Bachelor
CNKI	0.2	0.3	0.55
Wanfang	0	0.15	0.15
Superstar Books	0	0	0.1
Elsevier SD	0.7	0.45	0
Emerald	0	0	0
Others	0.1	0.2	0.2

Table 5 Third-Level Indicator of Dissertations in Art and Social Science

Database	Ph. D	Master	Bachelor
CNKI	0.3	0.35	0.4
Wanfang	0.25	0.25	0.3
Superstar Books	0.2	0.2	0.2
Elsevier SD	0	0	0
Emerald	0.15	0.1	0
Others	0.1	0.1	0.1

2.5 Assessment on Ub of Edbs Due to the Needs of Dissertations

In universities, Ph.D., Master's degree and undergraduate students commonly need to use EDBs to complete their dissertations. The academic outcomes acquired by students in the process of academic research training are usually included in the STAs of their advisors, but the STAs of undergraduate thesis are limited. Taking into account the great differences in the academic value of dissertations and the difficulty of assessing the UB of EDBs one by one, it is suggested that the scores of B_2,C_2 and E_2 articles listed in Table 1 are used as the first level indicator of the UB of EDBs for doctoral, master and bachelor's dissertations, respectively. To reasonably determine the second- and third-level indicators, the authors conducted a questionnaire survey in 2019 on 200 undergraduate students, 100 masters and 20 doctoral graduates who comes to the library for applying the permission of leaving school. The survey results show that 86% of the students think that their dissertations are highly dependent on the use of EDBs, while students in science and technology are highly dependent on the literatures provided by CNKI and Elsevier SD, whereas students in liberal art and social science mainly rely on those from CNKI, Wanfang, Superstar books and Emerald. Therefore, indicators listed in Tables 3, 4 and 5 are used for assessing UB of EDBs of dissertations in this exercise.

Table 6 the Third-Level Indicator of Funded Projects (I_3)

Database	Natural Science	Social Science
CNKI	0.15	0.3
Wanfang	0.1	0.25
Superstar Books	0	0.15
Elsevier SD	0.65	0
Emerald	0	0.2
Others	0.1	0.1

Table 7 the Third-Level Indicator of Academic Articles (I_3)

Database	Natural Science		Social Science	
	in Chinese	in English	in Chinese	in English
CNKI	0.4	0.15	0.3	0.25
Wanfang	0.25	0.05	0.25	0.2
Superstar Books	0	0	0.15	0.1
Elsevier SD	0.3	0.65	0	0
Emerald	0	0	0.2	0.35
Others	0.05	0.15	0.1	0.1

3. A Case Study

3.1 Data Source and the Identification of Third-Level Indicator for the Assessment

To exam the feasibility of assessment method on UB of EDBs for AP proposed in this work, the statistics of STAs in 2019 provided by Yunnan Normal University are employed as the data source for this case study, and a questionnaire survey was conducted on the use of five typical EDBs in the library for funding projects, research papers, academic books and other academic researches. The survey shows that funding projects and publication of academic articles are highly dependent on the relevant EDBs, while the writing of academic books are generally dependent on the use of EDBs, and the patent applications is less dependent on the use of EDBs. Therefore, I_2 is set to be 0.7 for funded projects and academic articles, whereas I_2 for academic books and patents are set to be 0.4 and 0.2, respectively. The three-level indicators for funded projects and academic papers listed in Tables 6 and 7 are used for the assessment on UB of various EDB. Because of the small number of academic books, their three-level indicators are determined directly by consulting the authors. The EDBs used for the application of patents are scattered, furthermore, few literatures and information from EDBs are used and thus I_3 is set to be zero in this work.

3.2 Results and Discussions

The AC and UB of five EDBs in YNNU obtained based on the assessment method proposed in this work are presented in Table 8. It is seen that the number of literature searches using CNKI is the highest and thus the cost of literature search is the lowest; the amount of downloads using Wanfang is the largest thus the cost of literature download is the lowest, and the cost of literatures downloaded from Elsevier SD is the highest; the UB of CNKI is the highest, followed by Elsevier SD in the case of dissertations being excluded, and the UB of Superstar Books is the lowest. This is because the academic literatures provided by CNKI and Elsevier SD cover the widest range of disciplines and subjects thus suitable for academic researches and funding of projects, and the documentation included in Superstar Books are mainly e-books and academic literatures are limited, thus UB of Superstar Books are not high and suitable for the needs of teaching and dissertation; Emerald includes English academic journals in the social science and management, thus mainly suitable for teachers, Ph.D. and Master's degree students to engage in related researches.

Table 8 the Use Cost and Ub of Five Edbs for Ap in Ynnu in 2019

Database	Number of Searches	Cost RMB/search	Downloads	Cost RMB/download	m_k /1000RMB	m_k /1000RMB (dissertations exclude)
CNKI	5395426	0.07	413277	0.92	3420.3	1089.4
Wangfang Database	1143259	0.32	565673	0.65	2045.4	479.1
Superstar books	-	-	164909	0.96	2602.8	345.2
Elsevier SD	-	-	286863	2.93	1022.5	672.9
Emerald	-	-	31466	2.86	873.3	568.2

4. Conclusions

The main purpose of purchasing EDBs in university libraries is to meet the needs of discipline construction and academic research in universities, so the quantified outcome of scientific researches in terms of score is an indirect indication of UB of EDBs for AP. In this work, an assessment method on UB of EDBs in university libraries is proposed with the quantitative STAs as the first level indicator, the dependence degree of acquisition of STAs on the use of EDBs as the second level indicator, and the contribution weight of each of related EDBs to the acquisition of STAs as the third level indicator. The first level indicator can be determined based on the identification method of STAs made by the school; the second level indicator can be identified based on the category or characteristics of STAs. The third level indicator is dependent on the discipline/subject to which the STA belongs, and should be determined by the owner of the achievements or assessed by questionnaire. To examine the feasibility of the assessment method proposed in this work, a case study is conducted based on the statistical data of STAs in 2019 provided by Yunnan Normal University and a questionnaire survey about the use of five typical EDBs in the library for funding projects, research papers, writing academic books and other academic activities. The results show that the CNKI is the best, followed by Elsevier SD and Wanfang worst in terms of annual UB of EDBs for unit capital investment.

It should be pointed out that the results obtained based on the assessment method proposed highly depend on the quantitative identification method of STAs formulated by universities, thus the results differ for different university. However, this does not affect its practical application. This is because the initiative of assessing UB of EDBs for AP is to compare and analyze the UB of various EDB purchased, and to examine whether the allocation of EDBs purchased meets the needs of discipline construction and development of the schools. Therefore, the results of quantitative UB of EDBs are helpful to adjust the allocation of electronic resources in schools in time so as to better meet the needs of discipline construction and academic research in the schools. The EDBs with higher AC of literatures and information and lower UB should not be considered in the next

financial budget, and the literatures and information required for academic reaerches can be obtained through other channels such as sharing platforms of EDBs.

5. Acknowledgment

This work is partial fulfillment of funded research program QN2017041, financially supported by Philosophical and Social Science Foundation of Yunnan, China.

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