Journal of Applied Mathematics and Physics, 2022, 10, 1642-1650
https://www.scirp.org/journal/jamp
ISSN Online: 2327-4379
ISSN Print: 2327-4352

An Evaluation Model of Graduation Thesis Results Based on Triangular Fuzzy Number

Hanxi Yang[1], Jiju Yin[2], Ailing Wang[2]

[1]Nanyang Commercial Bank, Shanghai, China
[2]Heze University, Heze, China
Email: 13905300115@163.com

How to cite this paper: Yang, H.X., Yin, J.J. and Wang, A.L. (2022) An Evaluation Model of Graduation Thesis Results Based on Triangular Fuzzy Number. *Journal of Applied Mathematics and Physics*, **10**, 1642-1650.
https://doi.org/10.4236/jamp.2022.105114

Received: April 11, 2022
Accepted: May 23, 2022
Published: May 26, 2022

Copyright © 2022 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/

Open Access

Abstract

The evaluation of thesis by undergraduate has the characteristics of multi-factor, multi-layer and easy to be affected by subjective factors. To reduce the subjectivity, triangular fuzzy number is used as index set to give weight, and on this basis, fuzzy comprehensive evaluation is used to evaluate the quality of graduation thesis. The empirical analysis shows that the combination of triangular fuzzy number and fuzzy comprehensive evaluation has certain practical value in the quality evaluation of graduation thesis.

Keywords

Ordinary Universities, Undergraduate Thesis, Triangular Fuzzy Number, Evaluation Model

1. Introduction

Writing thesis is an important learning process for college students before graduation, which plays a role in cultivating and investigating students' ability to comprehensively apply professional knowledge. Strengthening the quality construction of undergraduate thesis is of great significance to the realization of the goal of talent cultivation. It is an important indicator to measure the teaching level of colleges and universities, and also an important basis for the certification of students' degree qualifications. This means that undergraduate thesis is not a kind of formalities, but an important opportunity to improve the quality of talent training. We need to establish a set of quality evaluation system for graduation thesis to guide the development direction of graduation thesis writing leading students to the expected development of graduation thesis [1] [2] [3].

Fuzzy comprehensive evaluation is a branch of fuzzy mathematics founded by American famous professor Azadel in 1965. Now, there are three main ways of

undergraduate thesis evaluation: direct scoring method, weighted summation method and experience evaluation method. The above evaluation is mainly on the quality of the thesis and defense of the evaluation. There are also some colleges and universities to develop a detailed graduation thesis evaluation system, but because of the lack of scientific and operational failed to really implement. This paper tries to solve the problem of undergraduate thesis evaluation by means of comprehensive model through fuzzy mathematics.

2. Evaluation Index System of Graduation Thesis Quality

Evaluating the quality of graduation thesis involves many aspects which the system is complex. Thus in the establishment of the index system and the relative importance of the index value to determine the timing, it should be based on the actual needs of graduation thesis evaluation.

The establishment of the index system should adhere to the following principles: firstly, the scientific principle, that is, the design of the evaluation index should conform to the basic principles of education and management that can truly and objectively reflect the main points of graduation thesis writing, existing problems and development potential. Secondly, the principle of universality and comparability, that is, the designed evaluation index, system and evaluation results can be used in different schools and different majors which are easy to inter-school comparison. The third is the principle of systematicness and conciseness. It is necessary to adhere to the concept of system and take the complex factors of interdependence and mutual restriction into full consideration. Meanwhile, the indicator system should be avoided to be too complicated and complicated [4] [5] [6] [7]. Based on the above principles, an evaluation index system of undergraduate graduation thesis quality is established [8] [9] [10] [11], as shown in **Table 1**.

3. Fuzzy Analytic Hierarchy Process Is Used to Determine the Importance of Indicators

3.1. Construct Judgment Matrix

The construction of judgment matrix needs to compare the importance of each index. In the analytic hierarchy process (ahp), experts quantify the decision judgment based on the 1 - 9 scale, which is highly subjective. Here, the 1 - 9 scale method of ahp is combined with the tripartite method to reduce this subjectivity [12] [13] [14].

Table 2 is the triangular fuzzy judgment matrix made by the instructor, evaluation teacher and defense team.

3.2. Calculate Index Weight

1) The three fuzzy Numbers of each index are integrated into one

$$\left(\frac{k_{ij}^1 + k_{ij}^2 + k_{ij}^3}{3}, \frac{l_{ij}^1 + l_{ij}^2 + l_{ij}^3}{3}, \frac{m_{ij}^1 + m_{ij}^2 + m_{ij}^3}{3} \right)$$

Table 1. Quality evaluation index system of graduation thesis.

The overall goal	The indicator system Primary index B	Secondary index C
Graduation thesis Quality evaluation	Subject quality	Definite purpose Research makes sense Topic selection appropriate
	The paper quality	Title is consistent level o writing Normalization of writing
	Ability level	Ability to consult literature Ability to use knowledge comprehensively Ability to research solution design Ability to use research methods

Table 2. Triangular fuzzy judgment matrix.

	C_1	C_2	…	C_n
C_1	(1, 1, 1)	$\left(k_{12}^1, l_{12}^1, m_{12}^1\right)$ $\left(k_{12}^2, l_{12}^2, m_{12}^2\right)$ $\left(k_{12}^3, l_{12}^3, m_{12}^3\right)$	…	$\left(k_{1n}^1, l_{1n}^1, m_{1n}^1\right)$ $\left(k_{1n}^2, l_{1n}^2, m_{1n}^2\right)$ $\left(k_{1n}^3, l_{1n}^3, m_{1n}^3\right)$
C_2	$\left(k_{21}^1, l_{21}^1, m_{21}^1\right)$ $\left(k_{21}^2, l_{21}^2, m_{21}^2\right)$ $\left(k_{21}^3, l_{21}^3, m_{21}^3\right)$	(1, 1, 1)	…	$\left(k_{2n}^1, l_{2n}^1, m_{2n}^1\right)$ $\left(k_{2n}^2, l_{2n}^2, m_{2n}^2\right)$ $\left(k_{2n}^3, l_{2n}^3, m_{2n}^3\right)$
⋮	⋮		⋮	
C_n	$\left(k_{n1}^1, l_{n1}^1, m_{n1}^1\right)$ $\left(k_{n1}^2, l_{n1}^2, m_{n1}^2\right)$ $\left(k_{n1}^3, l_{n1}^3, m_{n1}^3\right)$	$\left(k_{n2}^1, l_{n2}^1, m_{n2}^1\right)$ $\left(k_{n2}^2, l_{n2}^2, m_{n2}^2\right)$ $\left(k_{n2}^3, l_{n2}^3, m_{n2}^3\right)$	…	$\left(k_{nn}^1, l_{nn}^1, m_{nn}^1\right)$ $\left(k_{nn}^2, l_{nn}^2, m_{nn}^2\right)$ $\left(k_{nn}^3, l_{nn}^3, m_{nn}^3\right)$

Among them $i = 1, 2, \cdots, n; j = 1, 2, \cdots, n$.

The resulting fuzzy matrix is as follows

$$\begin{bmatrix} (1,1,1) & (k_{12}, l_{12}, m_{12}) & \cdots & (k_{1n}, l_{1n}, m_{1n}) \\ (k_{21}, l_{21}, m_{21}) & (1,1,1) & \cdots & (k_{2n}, l_{2n}, m_{2n}) \\ \vdots & \vdots & \ddots & \vdots \\ (k_{n1}, l_{n1}, m_{n1}) & (k_{n2}, l_{n2}, m_{n2}) & \cdots & (1,1,1) \end{bmatrix}$$

2) The comprehensive fuzzy value (initial weight) D_i^k of the index i in layer K is calculated as follows

$$D_i^\tau = \sum_{j=1}^{n} a_{ij}^\tau \div \left(\sum_{i=1}^{n} \sum_{j=1}^{n} a_{ij}^\tau \right), i = 1, 2, \cdots, n; a_{ij} = \left(k_{ij}, l_{ij}, m_{ij}\right) \tag{1}$$

3) Defuzzification

Definition 1. $M_1\left(k_1, l_1, m_1\right)$ and $M_2\left(k_2, l_2, m_2\right)$ are trig fuzzy number. The probability of $M_2 \geq M_2$ expressed as a trigonometric fuzzy function

$$P\left(M_2 \geq M\right)_2 = \begin{cases} 1, l_1 \geq l_2 \\ \dfrac{k_2 - m_1}{\left(l_1 - m_1\right) - \left(l_2 - k_2\right)}, l_1 \leq l_2, m_1 \geq k_2 \end{cases} \tag{2}$$

Definition 2. The probability that one fuzzy number is greater than the other K fuzzy Numbers is defined as

$$P\left(M \geq M_1, M_2, \cdots, M_K\right) = \min P\left(M \geq M_i\right), i = 1, 2, \cdots, k$$

According to definitions 1 and 2 to D_i^r, formula (1) is used to de-blur

$$d_i = \min P\left(D_i^r \geq D_j^r, j = 1, 2, \cdots, n\right), i = 1, 2, \cdots, n$$

The weights above are normalized to obtain the final weights of each index $w = \left(\omega_1, \omega_2, \cdots, \omega_n\right)$.

4. Fuzzy Comprehensive Evaluation

1) Determination of evaluation set. Before carrying out comprehensive evaluation, the evaluation set shall be determined by the expert group. It is assumed that the evaluation of undergraduate graduation thesis results shall be divided into K grades, then the evaluation set shall be $F = \left\{f_1, f_2, \cdots, f_k\right\}$ Generally speaking, the fuzzy evaluation can be divided into 5 grades to meet the requirements of the evaluation, that is, f_1 means excellent, f_2 means good, f_3 means medium, f_4 means passing, f_5 means failing.

2) Evaluation model [5]. After the evaluation set is determined, the single indicator $u_i \left(i = 1, 2, \cdots, n\right)$ make a single index judgment, determine the membership degree (probability degree) r_{ij} of the decision level $v_j \left(j = 1, 2, \cdots, m\right)$ of the thing with respect to the index u_i, thus obtaining the single indicator evaluation set $r_i = \left(r_{i1}, r_{i2}, \cdots, r_{im}\right)$ of the ith factor u_i. The evaluation set of m indicators constitutes an evaluation matrix R.

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}$$

where r_{ij} represents the membership of the ith indicator to the jth decision level, $i = 1, 2, \cdots, n$, $j = 1, 2, \cdots, m$. We normally normalize it, which is satisfaction

$$\sum_{j=1}^{m} r_{ij} = 1\left(i = 1, 2, \cdots, n\right).$$

On this basis, firstly construct the fuzzy evaluation matrix P of fuzzy relation between the evaluation set F of each index B of the criterion layer, and then calculate the evaluation results of the index of the criterion layer.

$$Y_i = W_i \cdot R_i = \left(\omega_{i1}, \omega_{i2}, \cdots, \omega_{ih}\right) \cdot \begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i1m} \\ r_{i21} & r_{i22} & \cdots & r_{i2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{ih1} & r_{ih2} & \cdots & r_{ihm} \end{bmatrix} = \left(y_{i1}, y_{i2}, \cdots, y_{im}\right)$$

where, h is the number of lower indicators of criterion level indicator B_i.

Let's normalize Y_i

$$Y_i^* = \left(\frac{y_{i1}}{\sum_{j=1}^{m} y_{ij}}, \cdots, \frac{y_{im}}{\sum_{j=1}^{m} y_{ij}} \right) = \left(y_{i1}^*, y_{i2}^*, \cdots, y_{im}^* \right).$$

Then the fuzzy evaluation matrix of the fuzzy relationship between the evaluation set F of criterion level index can be expressed as

$$P = \begin{bmatrix} y_{11}^* & y_{12}^* & \cdots & y_{1m}^* \\ y_{21}^* & y_{22}^* & \cdots & y_{2m}^* \\ \vdots & \vdots & \ddots & \vdots \\ y_{n1}^* & y_{n2}^* & \cdots & y_{nm}^* \end{bmatrix}$$

Therefore, the evaluation result of target layer index can be calculated as

$$Y = W \cdot P = \left(\omega_1, \omega_2, \cdots, \omega_N \right) \cdot \begin{bmatrix} y_{11}^* & y_{12}^* & \cdots & y_{1m}^* \\ y_{21}^* & y_{22}^* & \cdots & y_{2m}^* \\ \vdots & \vdots & \ddots & \vdots \\ y_{n1}^* & y_{n2}^* & \cdots & y_{nm}^* \end{bmatrix} = \left(y_1, y_2, \cdots, y_m \right)$$

If I normalize Y, I get

$$Y^* = \left(\frac{y_1}{\sum_{j=1}^{m} y_j}, \cdots, \frac{y_m}{\sum_{j=1}^{m} y_j} \right) = \left(y_1^*, y_2^*, \cdots, y_m^* \right).$$

At this point, the final grade of comprehensive evaluation can be obtained according to the degree of membership [15] [16] [17].

5. Application Analysis

According to the above evaluation model, an ordinary institution of higher learning in eastern China is taken as an example to evaluate the quality of its undergraduate graduation thesis. The following is the fuzzy judgment matrix table (**Tables 3-5**) given by the expert group on the index system.

For the quality of undergraduate graduation thesis A, the quality of topic selection B_1, quality of thesis B_2 and level of ability B_3 at the criterion level are equally important. Through sorting out the evaluation data of 10 evaluation experts, the evaluation set of secondary indicators is obtained as shown in **Table 6**.

According to the above data, on the basis of the model calculation can get some east normal university undergraduate course graduation thesis quality comprehensive evaluation results Y^* = (0.19634, 0.239825, 0.28784, 0.13233, 0.11256), according to the principle of maximum membership degree, undergraduate course graduation thesis quality of the final evaluation result is 0.28784, namely "medium" which reflects the undergraduate graduation thesis is the school education relatively weak link that it needs to further improve.

Table 3. Quality of topic selection.

B_1	C_1	C_2	C_3
C_1	(1,1,1)	(1,2,3) (2,3,4) (1,2,3)	(1,2,3) (2,3,4) (2,4,5)
C_2	(1/3,1/2,1/1) (1/4,1/3,1/2) (1/3,1/2,1/1)	(1,1,1)	(1,3,4) (1,4,5) (1,2,3)
C_3	(1/3,1/2,1/1) (1/4,1/3,1/2) (1/5,1/4,1/2)	(1/4,1/3,1/1) (1/5,1/4,1/1) (1/3,1/2,1/1)	(1,1,1)

Table 4. Quality of the paper.

B_2	C_4	C_5	C_6
C_4	(1,1,1)	(1,2,4) (2,3,4) (1,3,4)	(1,2,3) (1,2,3) (1,1,2)
C_5	(1/4,1/2,1/1) (1/4,1/3,1/2) (1/4,1/3,1/1)	(1,1,1)	(1,3,4) (1,1,2) (1,2,4)
C_6	(1/3,1/2,1/1) (1/3,1/2,1/1) (1/2,1/1,1/1)	(1/4,1/3,1/1) (1/2,1/1,1/1) (1/4,1/2,1/1)	(1,1,1)

Table 5. Ability level.

B_3	C_7	C_8	C_9	C_{10}
C_7	(1,1,1)	(1,1,2) (1,1,2) (1,2,3)	(1,2,3) (1,1,2) (1,1,2)	(3,4,5) (2,3,4) (3,4,5)
C_8	(1/2,1/1,1/1) (1/2,1/1,1/1) (1/3,1/2,1/1)	(1,1,1)	(1,2,3) (1,1,2) (1,1,2)	(2,3,4) (1,2,3) (2,3,4)
C_9	(1/3,1/2,1/1) (1/2,1/1,1/1) (1/2,1/1,1/1)	(1/3,1/2,1/1) (1/2,1/1,1/1) (1/2,1/1,1/1)	(1,1,1)	(2,3,4) (1,2,3) (1,2,3)
C_{10}	(1/5,1/4,1/3) (1/4,1/3,1/2) (1/5,1/4,1/3)	(1/4,1/3,1/2) (1/3,1/2,1/1) (1/4,1/3,1/2)	(1/4,1/3,1/2) (1/3,1/2,1/1) (1/3,1/2,1/1)	(1,1,1)

Table 6. Evaluation set of secondary indicators of undergraduate graduation thesis quality

Criterion level index B	Scheme level indicator C	Comment set (number of participants)				
		f_1 excellent	f_2 good	f_3 medium	f_4 passing	f_5 falling
B_1	C_1	2	2	3	2	1
	C_2	2	3	3	1	1
	C_3	2	3	2	2	1
B_2	C_4	2	1	4	2	1
	C_5	2	3	3	1	1
	C_6	1	1	5	2	1
B_3	C_7	2	3	2	2	1
	C_8	3	2	2	2	1
	C_9	2	2	4	2	1
	C_{10}	1	3	3	2	1

6. Conclusion

According to the requirements of the current society for talents, on the basis of consulting experts and practical investigation, the evaluation index system of undergraduate graduation thesis quality is constructed based on the principles of scientificness, directivity, comprehensiveness, hierarchy, individuality and operability. In view of the characteristic that the evaluation indexes of undergraduate graduation thesis are mostly qualitative indexes, the analytic hierarchy process based on triangle fuzzy number is introduced into the evaluation of undergraduate graduation thesis, and the factors affecting the quality of undergraduate graduation thesis are sorted, and the quality evaluation model of undergraduate graduation thesis is constructed by using fuzzy comprehensive evaluation method. The results show that the model can well reflect the quality of undergraduate theses in ordinary universities.

Declarations

Ethics Approval and Consent to Participate

The investigation and research process has been agreed by the Academic Committee of Heze University, and the data collection has also been agreed by the teachers and experts participating in the evaluation. Because the evaluations involved student papers, the data were collected with the consent of the students concerned.

Consent for Publication

The author agrees to publish, and the colleges, teachers and students related to the thesis agree to publish.

Availability of Data and Material

The data comes from the evaluation of the undergraduate thesis by experts and

teachers, which is authentic and reliable.

Funding

Fund Project: Mathematical model establishment and problem solving (Heze University, No. XY19BS21). This research was supported by the project.

Authors' Contributions

This research was completed by Yang Hanxi, Yin Jiju, and Wang Ailing, who were responsible for the research methods, data collection, mathematical analysis and paper formation without controversy.

Acknowledgements

Yang Hanxi (1994.11-): Employee of Nanyang Commercial Bank. Research interests: Fuzzy evaluation.

Yin Jiju (1995.7-): Graduate student of Heze University. Research interests: Mathematical modeling.

Wang Ailing (1969.06-): PhD of East China normal university, Heze university professor. Research interests: Mathematical modeling and problem solving.

Conflicts of Interest

There is no conflict of interest in the paper, which is approved by relevant experts, teachers and students.

References

[1] Suo, H.J. (2015) Discussion on the Significance of Existence of Undergraduate Graduation Thesis. *Industry and Technology Forum*, No. 15, 34-39.

[2] Dang, T.J. and Yan, Z.J. (2015) Research on the Educational Function of Undergraduate Graduation Thesis of Modern University of China. *Education and Examination*, No. 1, 87-94.

[3] Sun, Z.S. and Bi, Z.T. (2015) Key Points and Skills of Undergraduate Thesis Writing Guidance—Research Implementation and Thesis Writing. *Journal of Zhejiang University of Science and Technology*, No. 2, 8-14.

[4] Li, W. and Ouyang, S. (2012) Analysis on Factors Affecting the Quality of Undergraduate Graduation Thesis. *Journal of Southwest Agricultural University*, No. 9, 77-83.

[5] Zhang, X.L. (2012) Some Problems Existing in Undergraduate Graduation Thesis and Their Countermeasures. *Journal of Changchun University of Science and Technology*, No. 10, 18-22.

[6] Hu, B.Q. (2004) Basis of Fuzzy Theory. Wuhan University Press, Wuhan.

[7] Li, T. and Fu, X.M. (2009) Research on Fuzzy Comprehensive Evaluation of Multimedia Teaching in Colleges and Universities. *China Adult Education*, **41**, 102-105.

[8] Guang, J.F., Yue, J.Z. and Hui, J.W. (2014) The Study of Improving the Quality of Petroleum Geology Undergraduate Course Graduation Design. *Advanced Materials Research*, No. 9, 121-126.

[9] Huang, M.Y. and Mu, R. (2012) Research on Teaching Quality Evaluation Based on

Fuzzy Analytic Hierarchy Process. *Journal of Southwest University for Nationalities*, **38**, 507-511.

[10] Bellas, M.L. (2001) Investment in Higher Education: Do Labor Market Opportunities Differ by Age of Recent College Graduates. *Research in Higher Education*, **42**, 1-25. https://doi.org/10.1023/A:1018786610185

[11] Guo, C.H. (2009) An Empirical Study on the Quality Assessment of Undergraduate Thesis in Shanghai. *Chinese Education & Society*, **42**, 81-94. https://doi.org/10.2753/CED1061-1932420107

[12] Mao, S.C. (2013) Empirical Study on the Quality Evaluation of Undergraduate Thesis. South China University of Technology, Guangzhou.

[13] Geiger, R.L. (1986) To Advance Knowledge—The Growth of American Research University 1900-1940. Oxford Universities Press, London.

[14] Fan, Z.F. and Wang, C. (2016) Effectiveness Evaluation Model and Application of Flow-Based Communication Support Contingency Plan. *Science and Technology Management Research*, 36, 67-74.

[15] Song, Y.H., Chen, C., Fang, D.H., *et al.* (2008) Evaluation of Urban Flood Emergency Plan Based on Evidence Theory. *Industrial Safety and Environmental Protection*, 44, 16-23.

[16] Chang, J., Du, Y.X. and Liu, W.F. (2016) Intuitionistic Triangular Fuzzy Number Density Operator and Its Decision Application. *Mathematical Practice and Cognition*, 46, 38-45.

[17] Deng, J. and Lu, Q. (2018) Fuzzy Regression Model Based on Fuzzy Distance Measure. *Journal of Data Analysis and Information Processing*, **6**, 126-140. https://doi.org/10.4236/jdaip.2018.63008

Abbreviations

ahp: analytic hierarchy process