How to Construct an Index System to Evaluate the Undergraduate Thesis Quality—An Empirical Research of Economics and Management Major in an Applied University

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Abstract. The purpose of this study is to construct a scientific and reasonable quality evaluation system of undergraduate thesis in an Applied University and improve the quality of undergraduate thesis in an Applied University. MATLAB is used to get the results by dealing with the data obtained through structured questionnaire survey from a sample of 185 undergraduates and 20 instructors majoring in Investment and Management Science and 10 relevant experts. Quality Evaluation System is directly and positively associated with the quality of undergraduate thesis in an Applied University. Analytic Hierarchy Process is helpful for establishing a scientific and reasonable quality evaluation system in that it provides a better work for the situation where it is difficult to measure the evaluation target directly and accurately. Successful implementations of Analytic Hierarchy Process support the implementation of establishing a scientific and reasonable quality evaluation system of undergraduate thesis leading to improved quality of undergraduate thesis in an Applied University. The study of this thesis has a good reference value for scientifically determining the weight of the quality evaluation indicator of graduation, and provides ideas for improving the scientific and effectiveness of undergraduate thesis quality evaluation.

Introduction

In recent years, the quality of undergraduate thesis of many universities has the overall trend of landslide, which of economics and management majors in an Applied University is particularly serious. There are many problems such as copy, vacuousness, lack of innovation, non-fluency of sentences, form-ism of dissertation defense, which have a negative effect on the talents training quality of an Applied University. There are many reasons for the above problems, one of which is the unclear quality evaluation standard and the incomplete evaluation system. Therefore, the establishment of a scientific and effective quality evaluation system of undergraduate thesis is the most important work in the management of undergraduate thesis, also is the key to improve the quality of undergraduate thesis. But the quality evaluation of undergraduate thesis is a complicated and multi-indicator comprehensive evaluation problem. In the evaluation system, the indicators of each level have different importance, which are difficult to be compared and quantified. To accurately evaluate the quality of undergraduate thesis is supposed to scientifically quantify the importance of every indicator, namely, scientifically determine the weight. Analytic Hierarchy Process provides a reliable solution for determining the indicators and their weights of quality evaluation system of undergraduate thesis scientifically.
The Establishment of Quality Evaluation System of Undergraduate Thesis in an Applied University Based on the AHP

Selection of Indicators

On the basis of literature investigation and the questionnaire survey conducted by a sample of 185 undergraduates and 20 instructors majoring in Investment and Management Science in a local applied university who have just completed the 2018 undergraduate thesis and 10 relevant experts, the quality evaluation indicators of undergraduate thesis are refined with methods such as sorting, scoring, and correlation analysis. The selected indicators as shown in Table 1.

Table 1. Quality Evaluation indicator of Undergraduate Thesis.

| The Quality of Undergraduate Thesis A | B1  | B2  | B3  | B4  |
|---------------------------------------|-----|-----|-----|-----|
| Topic Selection Quality B1            |     |     |     |     |
| signficance and practical value of the selected topic B11 | | | | |
| novelty and frontier of the selected topic B12 | | | | |
| appropriateness and operability of the selected topic B13 | | | | |
| literature review ability B14 | | | | |
| Writing Quality B2 | | | | |
| level of professional theoretical knowledge B21 | | | | |
| level of research method and application of research tools B22 | | | | |
| level of correct and distinct arguments, clear and reliable conclusions B23 | | | | |
| clear hierarchical structure, strong logic and language fluency B24 | | | | |
| level of foreign language B25 | | | | |
| level of content, full workload, and length meeting requirements B26 | | | | |
| Academic Norms B3 | | | | |
| Complete projects (abstract, catalog, text, references, acknowledgments, appendices, etc.)B31 | | | | |
| Standard formats (correct punctuation, standard writing and typesetting, etc.)B32 | | | | |
| similarity rate B33 | | | | |
| citation and labeling B34 | | | | |
| Defense Quality B4 | | | | |
| Undergraduates’ attitude and appearance B41 | | | | |
| language expression ability B42 | | | | |
| PPT making and other comprehensive abilities B43 | | | | |

The Determination of Indicator Weight

Step 1: Establish the hierarchical structure model. A hierarchical structure model can be established according to the quality evaluation indicator of the Undergraduate thesis of investment major in an Applied University established above, as shown in figure 1.
The top of the hierarchy is the target of the research, which usually consists of only one factor. The factor of the middle layer is the criterion layer, which is composed of four secondary indicators, namely, the quality of selected topic \( B_1 \), the quality of research \( B_2 \), the quality of writing \( B_3 \) and the quality of defense \( B_4 \). The factor of the lowest level is the indicator level, which is composed of 21 three-level indicators such as the significance and practical value of the topic \( B_{11} \).

Step 2: construct judgment matrix. After the establishment of the hierarchical structure model, it is necessary to make a pairwise comparison of the importance of each factor in each level relative to the factors in the previous level and build a judgment matrix. The value of the element of the judgment matrix reflects people’s subjective understanding and evaluation of the relative importance of various factors, and 1, 3, 5, 7, 9 and its reciprocal are usually taken as the scale. 2, 4, 6, 8 are the scale corresponding to the intermediate state between the above adjacent judgments. The scale and meaning of the judgment matrix are shown in table 2.

### Table 2. Scale and Meaning of Judgment Matrix.

| scale \( a_{ij} \) | meaning                                                                 |
|-------------------|-------------------------------------------------------------------------|
| 1                 | Factor i is as important as factor j                                     |
| 3                 | Factor i is slightly more important than factor j                        |
| 5                 | Factor i is significantly more important than factor j                   |
| 7                 | Factor i is more important than factor j                                 |
| 9                 | Factor i is more important than factor j                                 |
| 2468              | The scale corresponding to the intermediate state between the above adjacent judgments |
| The bottom        | If factor j is compared with factor i, the judgment value obtained is \( a_{ji} = 1/a_{ij} \) |

The construction of judgment matrix is the key of AHP, which will directly affect the calculation result of importance weight. In this thesis, a total of 10 undergraduate thesis instructors majoring in investment were invited to compare and evaluate the indicators in table 1 by using the expert scoring method. After independent evaluation by instructors, the arithmetic mean of the data was
taken and rounded, and the comparison results of two indicators were obtained. Finally, five judgment matrix were obtained, as shown in table 3 ~ table 7.

Table 3. Judgment Matrix of Standard Layer.

| A                        | B₁     | B₂     | B₃     | B₄     |
|--------------------------|--------|--------|--------|--------|
| Topic selection quality B₁ | 1      | 1/2    | 2      | 2      |
| Writing quality B₂       | 2      | 1      | 4      | 4      |
| Academic Norms B₃        | 1/2    | 1/4    | 1      | 1      |
| Defense quality B₄       | 1/2    | 1/4    | 1      | 1      |

Table 4. Judgment Matrix of Topic Selection Quality B₁.

|                      | B₁₁    | B₁₂     | B₁₃    | B₁₄emme:|
|----------------------|--------|---------|--------|---------|
| Significance and practical value of the selected topic | 1      | 2      | 1      | 1/2    |
| Novelty and frontier of the selected topic B₁₂       | 1/2    | 1      | 1/2    | 1/4    |
| Appropriateness and operability of the selected topic B₁₃ | 1      | 2      | 1      | 1/2    |
| Literature review ability B₁₄                           | 2      | 4      | 2      | 1      |

Table 5. Judgment Matrix of Writing Quality B₂.

|                      | B₂₁    | B₂₂     | B₂₃      | B₂₄    | B₂₅    | B₂₆     |
|----------------------|--------|---------|----------|--------|--------|---------|
| Level of professional theoretical Knowledge B₂₁       | 1      | 1      | 2        | 3      | 4      | 3       |
| Level of research method and Application of research tools B₂₂ | 1      | 1      | 2        | 3      | 4      | 3       |
| Level of correct and distinct Arguments, clear and reliable Conclusions B₂₃       | 1/2    | 1/2    | 1        | 2      | 3      | 2       |
| Clear hierarchical structure, strong Logic and language fluency B₂₄       | 1/3    | 1/3    | 1/2      | 1      | 2      | 1       |
| Level of foreign language B₂₅                                              | 1/4    | 1/4    | 1/3      | 1/2    | 1      | 1/2     |
| Level of content, full workload, and length meeting requirements B₂₆       | 1/3    | 1/3    | 1/2      | 1      | 2      | 1       |

Table 6. Judgment Matrix of Academic Norms B₃.

|                      | B₃₁    | B₃₂     | B₃₃    | B₃₄    |
|----------------------|--------|---------|--------|--------|
| Complete projects (abstract, catalog, text, references, Acknowledgements, appendices, etc.) B₃₁ | 1      | 2      | 1/2    | 3      |
| Standard formats (correct punctuation, standard writing and typesetting, etc.) B₃₂ | 1/2    | 1      | 1/4    | 2      |
| Similarity rate B₃₃                                              | 2      | 4      | 1      | 5      |
| Citation and labeling B₃₄                                           | 1/3    | 1/2    | 1/5    | 1      |
Table 7. Judgment Matrix of Defense Quality $B_4$.

| $B_4$ | $B_{41}$ | $B_{42}$ | $B_{43}$ |
|-------|---------|---------|---------|
| Undergraduates’ attitude and appearance $B_{41}$ | 1 | 1/2 | 1 |
| Language expression ability $B_{42}$ | 2 | 1 | 2 |
| PPT making and other comprehensive abilities $B_{43}$ | 1 | 1/2 | 1 |

Step 3: Calculating by MATLAB.

Step 4: consistency test. It is required to test the consistency to judge if it is reasonable to take the eigenvector obtained from the constructed judgment matrix as the weight due to the complexity of objective things and the partial of people’s understanding of objective things. The steps are as follows:

1. Calculate the consistency indicator CI, $CI = \frac{\lambda_{\text{max}} - n}{n - 1}$.
   The smaller the CI value is, the closer the judgment matrix is to complete consistency; the larger the CI value is, the worse the consistency of the judgment matrix is.

2. Calculate the consistency ratio CR by comparing CI with the random consistency indicator RI.
   Usually, the value of RI can be obtained by looking up the table. Table 8 shows the value of RI in dimension 1-10.
### Table 8. Values of RI.

| Dimension | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| RI        | 0.00| 0.00| 0.58| 0.90| 1.12| 1.24| 1.32| 1.41| 1.46| 1.49 |

(3) Calculate the consistency ratio CR. CR = CI/RI, as long as meet CR < 0.1, it is generally accepted that the consistency of the judgment matrix is acceptable.

The five judgment matrices shown in table 3-7 were input successively, and the eigenvalues and consistency test results of the judgment matrix obtained through program calculation were summarized as follows.

### Table 9. Eigenvalues and Consistency Test Results.

| Item  | $\lambda_{\text{max}}$ | CI   | CR   | Consistency Test | Eigenvector Normalization |
|-------|------------------|------|------|------------------|--------------------------|
| Table3 | 4                | 0    | 0    | acceptance       | $[0.3538, 0.5582, 0.044, 0.044]^T$ |
| Table4 | 4                | 0    | 0    | acceptance       | $[0.0717, 0.0939, 0.2764, 0.5580]^T$ |
| Table5 | 6.041           | 0.008| 0.006| acceptance       | $[0.3938, 0.3938, 0.1221, 0.0409, 0.0087, 0.0409]^T$ |
| Table6 | 4.021           | 0.007| 0.007| acceptance       | $[0.2170, 0.0431, 0.7251, 0.0147]^T$ |
| Table7 | 3                | 0    | 0    | acceptance       | $[0.1616, 0.7017, 0.1367]^T$ |

Step 5: General hierarchy and consistency checking. The overall ranking of the hierarchy is to multiply the weight of each level with the weight of the previous level, that is, to obtain the comprehensive weight of the entire evaluation system. The results are shown in table 10.

### Table 10. Calculated Weight of Quality Evaluation Indicator for Undergraduate Thesis.

| Quality Evaluation System of Undergraduate Thesis | Level 1 Indicators | Weight | Level 2 Indicators | Classification Weight | Synthesis Weight |
|--------------------------------------------------|--------------------|--------|--------------------|----------------------|-----------------|
| Topic Selection Quality B₁                         | 0.3538             |        | Significance and practical value of the selected topic $B_{11}$ | 0.7947              | 0.3424          |
|                                                   |                    |        | Novelty and frontier of the selected topic $B_{12}$ | 0.1325              | 0.0571          |
|                                                   |                    |        | Appropriateness and operability of the selected topic $B_{13}$ | 0.2649              | 0.1141          |
|                                                   |                    |        | Literature review ability $B_{14}$ | 0.5298              | 0.2283          |
| Writing Quality B₂                                | 0.5582             |        | Level of professional theoretical knowledge $B_{21}$ | 0.5188              | 0.4470          |
|                                                   |                    |        | Level of research method and application of research tools $B_{22}$ | 0.5188              | 0.4470          |
|                                                   |                    |        | Level of correct and distinct arguments, clear and reliable conclusions $B_{23}$ | 0.5188              | 0.4470          |
|                                                   |                    |        | Clear hierarchical structure, strong logic and language fluency $B_{24}$ | 0.2755              | 0.2374          |
|                                                   |                    |        | Level of foreign language $B_{25}$ | 0.2021              | 0.1741          |
|                                                   |                    |        | Level of content, full workload, and length meeting requirements $B_{26}$ | 0.2755              | 0.2374          |
| Academic Norms B₃                                 | 0.0440             |        | Complete projects (abstract, catalog, text, references, acknowledgements, appendices,) | 0.4437              | 0.059           |
Thus, the total weight vector can be obtained
\[ W = [0.164, 0.082, 0.027, 0.047, 0.012, 0.093, 0.019, 0.009, 0.038, 0.330, 0.117, 0.062]^T. \]

Check the consistency of the overall sorting of the hierarchy:
C.R. = C.I./R.I. < 0.1. Indicates that the overall hierarchy is consistent.

**Case Validation**

An undergraduate thesis of 2018 undergraduates majoring in investment is selected and evaluated with the evaluation system shown in Table 11 and five instructors majoring in investment and an industry thesis Instructor are employed to evaluate the thesis. Five of them are: one instructor, one reviewer and three defense instructors. Five of them are a thesis instructor, a thesis reviewer and three thesis defense instructors. Thesis instructors are required to evaluate the first-level indicator of topic selection quality and its four secondary indicators; school instructors and reviewing instructors are required to evaluate the quality of thesis topics, which is first-level indicator and four second-level indicators included. Instructors and evaluation instructors in the school evaluate the quality of the topics, the quality of research, and the quality of writing, which are first-level indicators and 14 second-level indicators included. Thesis defense instructors need to evaluate four first-level indicators and 17 second-level indicators, that is, to evaluate all indicators. The comprehensive results of thesis are obtained by summing up the results of Topic Selection Quality, Writing Quality, Academic Norms and Defense Quality. Topic Selection Quality is weighted by the results of industry instructors, school instructors, evaluation instructors and thesis defense instructors and the weight of the four is calculated according to 30%, 30%, 20% and 20%. The three scores of Topic Selection Quality, Writing Quality and Academic Norms should be weighted by the school instructors, evaluation instructors and defense instructors, and the weights of the three should be calculated according to 40%, 30% and 30%. After calculation, the student’s score is 89, which belongs to a good grade. After that, the student’s thesis was evaluated as a good thesis by many experts hired by the school, which can prove that the quality evaluation system of the undergraduate thesis of economics and management major in an Applied University designed in this thesis has good reliability and validity.

**Conclusions**

The results were obtained by using MATLAB software to process the data obtained from a structured questionnaire survey of 185 undergraduates majoring in investment and management, 20 instructors and 10 undergraduates majoring in investment and management. It can be concluded that the quality evaluation system of undergraduate thesis in an Applied University should be jointly determined by the four first-level indicators of topic selection quality \( B_{11} \), Writing quality \( B_2 \), Academic Norms \( B_3 \), and the defense quality \( B_4 \) and 17 second-level indicators of significance and practical value of the selected topic \( B_{11} \) according to the above analysis. Among all the indicators, level of professional theoretical knowledge \( B_{21} \), level of research method and application of research tools \( B_{22} \), literature review ability \( B_{14} \) are the four most important key secondary
indicators to measure the quality of the thesis, and their weights are respectively, 0.2198, 0.2198, and 0.1974.

**Implication**

The study has certain reference value for improving the scientific city and validity of the quality evaluation of undergraduate thesis in an Applied University. The design of structured questionnaire and the selection of expert and sample undergraduates and instructors. The sample is limited to undergraduates majoring in Investment and Management Science, with a low response rate.

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