The Assessment of SAS Accreditation for BBA Programs on University Statistics Learning

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ABSTRACT

Traditional mathematical methods built around exactitude have limitations when applied to the processing of educational information, due to their uncertainty and imperfection. Alternative mathematical methods, such as grey system theory, have been widely applied in processing incomplete information systems and have proven effective in a number of fields. In this study, an assessment indicator system is developed, based on the BBA (Bachelor of Business Administration) program of Guangdong University of Foreign Studies (GDUFS), through statistics building on the initial indicators of the SAS (Statistical Analysis System) assessment system in China. The proposed system assesses the accredited indicators of the GDUFS BBA program using grey comprehensive evaluation methodology. The results accord with the actual situation, supporting the accuracy of the assessment model, research theory and methodology. In addition, this paper analyses and sorts degrees of satisfaction for program indicators with the adoption of the grey correlation analysis method, to provide a basis for decision-making.

Key words: Multilevel comprehensive assessment, International accreditation, SAS, Business programs.
INTRODUCTION

In recent years, information technology and computer science has developed rapidly with wide application in many fields, leading to a qualitative breakthrough in the scale of industrial application systems. The data generated have exploded and today we are in the era of Big Data. Data have been regarded as the most competitive and valuable assets, and the value of Big Data has aroused great attention from various industries. However, many businesses have encountered some problems in getting adjusted to this trend and the key is the shortage for Big Data talents. The high-end Big Data talents are a kind of compound talents with Big Data processing ability and a good command of knowledge in mathematics, statistics, data analysis, and machine learning. Practice is an important part of talent cultivation in institutions of higher learning and it is of great significance to train students in their comprehensive use of theoretical knowledge and skills to solve real-life problems to improve their practical, innovative, and collaborative capabilities. This is the way to train Chinese talents for the applied fields. With the rapid development of science and technology, university undergraduates should possess certain data analysis capabilities in order to meet the needs of modern society, which is also one of the requirements for undergraduates’ comprehensive quality.

In 2015, Guangdong University of Foreign Studies introduced the SAS (Statistical Analysis System) accreditation program, embedded in the Bachelor of Business Administration syllabus. Since its introduction, SAS has been developed into an integrated application software system with powerful functions and flexible use. It defines the statistical analysis method as a calculation process, which can be directly used during analysis. This system has complete data access, data management and analysis, and presentation functions and is the internationally authoritative standard software for data processing and statistical analysis.
The SAS China (China SAS Accreditation System) is a set of SAS software application skills certification systems designed specifically for China based on the actual employment needs of many large Chinese enterprises and with reference to the SAS global certification system standards. SAS China Accreditation is a measure of the holders’ actual application level of SAS software, which serves as guidance for the employee selection and employment by enterprises. SAS China is a recognized accreditation in the field of data mining and business intelligence. In the context of the current global competition, business intelligence has become hot technology and domestic companies are paying more and more attention to refined management, quantitative analysis and risk control. Businesses have formed and expanded business intelligence and business analysis teams. Obtaining the global professional certificate of SAS is not only a reflection of the students’ technical capabilities, but also a great help for them to enter the workplace.

### Contribution of this paper to the literature

- The multi-level grey assessment method can classify the scattered information of different assessors into vectors of different grey clusters, and standardizes those vectors. Except in determining the grades of the assessment object, the results can also be used as the basis for the assessor to sort the values of different grey assessment objects at one time, and can provide suggestions for improving each indicator.
- By using the comprehensive assessment indicator system and the grey comprehensive evaluation method, the indicators of BBA project of Guangdong University of Foreign Studies after SAS certification are tested and evaluated, which illustrates the importance of statistics education and the application of SAS statistics software in business projects. The results accord with the actual situation, supporting the accuracy of the assessment model, research theory and methodology adopted in this paper.
- Students trained through certified SAS Projects are able to use advanced technology such as data management, data analysis and business modelling to solve real-life business problems and to develop the ability to obtain information from data to predict future trends and behaviour patterns. This enables them to use theories and methods of business analysis to solve management and technical problems and to help enterprises to make use of data to gain a competitive advantage, which not only promotes their professional development in the field of data analysis but also helps to meet the growing demand for Big Data analysis.
LITERATURE REVIEW

Judith S. Milton, chairman of the Council for Higher Education Accreditation (CHEA), pointed out that accreditation is the most fundamental method for institutions of higher education to guarantee and improve the quality of their education. She noted that higher education accreditation plays four important roles: ensuring and improving quality of education, guaranteeing the academic value of higher education, avoiding political influence and intervention on education, and serving the public interest. Hedrick (2010) carried out a quantitative study on international accreditation output, and the results indicated that teachers working for accredited business schools get higher salaries and published more research, when compared with their peers working for non-accredited schools.

Zhang (2009), conducting an assessment on government participation in higher education for the United States, the United Kingdom, and France, classified three categories of government participation therein: the social autonomous model, the government-guiding model, and the government-centralizing model, respectively. Crow (2009) pointed out that more research on accreditation organizations should be made on seven aspects, including strengthening peer coordination and cooperation, increasing transparency, clarifying basic objectives of accreditation, re-examining peer assessment methods, studying threats in peer assessment, creating interaction opportunities for low risk and high return amongst peers, and blazing new trails for funding. Zhang and Yang (2010) posited that professional accreditation organizations in the United States are mostly industry associations or institutions developed from trade associations. This makes them more acceptable for professional-oriented universities, as well as more attractive to professional managers for participation. Their unofficial nature helps accreditation organizations better fulfil their obligations to make unbiased assessments. Deng (2005) holds the view that the nature and mission of a professional degree education program layout largely depends on the maturity of the given profession. In other words, a professional degree can be established only when the profession becomes highly specialized. A professional degree education is essentially a kind of vocational education. White and Mayo (2005) drew the conclusion that practical skills are more important than basic knowledge in student learning and employment.

Meng and Yuan (2015) compared China and the U.S. syllabus of statistics major for
undergraduates and pointed out that there are still some gaps in learning objectives, curriculum design and teaching content in the era of Big Data. Zhu and Li (2014) believed that the construction of China’s curriculum for majors related with Big Data should comprehensively take into account of the knowledge and skills which should be possessed by Big Data professionals, and China should actively learn from the developed countries for the cultivation of Big Data professionals. To solve the problem of the shortage for Big Data talents, we need to learn from the experience of foreign countries. In recent years, this has also attracted the attention of many scholars. Geng (2014), taking into account of the Big Data research trends at home and abroad, pointed out that research on Big Data analysis requires the introduction of international certification. He (2014), through deep analysis of the websites of Big Data analysis courses of 23 well-known universities in the U.S., summed up that the U.S. universities attach great value to practice and the SAS application in the master degree curriculum for data science majors. Ruan and Chen (2015), by taking the well-known Big Data projects of more than 20 colleges and universities in the U.S. as examples, discussed the training model of Big Data analysis talents for software application certification in China. Delia (2014), basing on the examples of the colleges and universities offering master programs in data science, analyzed the content and characteristics of SAS courses at home and abroad, and proposed strategies to improve the SAS certification in Chinese universities. Nowadays most of the researches on the cultivation of Big Data talents are on macro policy, with few on the implementation effects and specific conditions of universities.

THEORETICAL FRAMEWORK

In systems theory and cybernetics, colors are often used to present the degrees of a researchers’ understanding of a given system and its internal information. “Black” refers to information that is completely unavailable, while “white” represents information that is completely known. “Grey” is defined as information that is not sufficient, yet not completely lacking. Therefore, systems with incomplete information are referred to as grey systems. The research object of a grey system is information that is partially known and partially unknown. These grey systems are also referred to as “poor systems” or “uncertain systems”. They achieve a precise description and understanding of the real
world by generating and exploring known information. In other words, grey system theory is mainly used to clarify unknown information with the help of known information, so as to make grey systems into white systems.

A major feature of this methodology is that there are no strict requirements for sample sizes or the distribution forms that the samples should follow. Social and economic systems have obvious complexity in levels, ambiguity of structural relations, randomness of dynamic changes, imperfections, and uncertainties in indicator data. Multiple factors, including technical methods and human behaviour, can lead to data errors and shortages. Even false data will generate greyness. Due to the ubiquity of grey systems, grey system theory has a great potential for future development in application.

Systems analysis aims to clarify the major and minor factors that affect a system. Traditional systems analysis methods are mostly comprised of mathematical statistical models, such as regression analysis, variance analysis, and principal component analysis. Among them, regression analysis is most commonly used method. However, regression analysis have relatively obvious limitations, such as large sample size requirements, significant distribution, regularity of samples, and large amounts of calculation. Additionally, quantified results can sometimes be inconsistent with the results of qualitative analyses. Grey system theory presents us with a new analysis method, named the grey correlation analysis, which measures the degree of correlation between factors based on the similarities or differences in their developmental status. This method has a relatively low requirement for sample size as well as for distribution and calculation. All random processes are grey processes that change within a certain range. Although they appear complex and chaotic, the results always have some overall functions, orders, and hidden regularities. The basis of grey system theory modeling is generating and accumulating data based on the original chaotic variables, so as to find their approximate exponential laws.

In some situations, researchers are not fully aware of specific factors regarding the assessment object, resulting in a lack of foundation for decision-making. Similarly, researchers can find that the object of study vanishes due to an understanding that lags behind the reality of a situation (because of an object’s continuous development and change, for example). A researcher’s judgment can also deviate under the influence of false information and disinformation. All of these situations may result in incomplete
information; that is, greyness. Grey system theory is a theory for researching and processing complex relations, but doing so while starting with incomplete information. It does not begin with specific regularities within a system, but with the mathematical processing of a given observation at a certain level in the system. This is done to understand the mechanisms inside the systems at a higher level, such as changing trends or mutual relations. Grey correlation analysis are one of the major applications of grey system theory. The grey comprehensive evaluation method is based on the grey correlation analysis, and compares and sorts assessment objects according to specific factors and the degree of relevancy among optimal standards.

The cultivation and education of business talents is a complex system as well as a professional activity that is multi-factored, multi-level, and changeable. It concerns all aspects of the students and faculty in a given university program, representing an entire process. The formation mechanism of a school’s quality of education is rather complicated, and often exhibits complexity and greyness in assessment. Practice shows that when used properly, the grey system theory can more effectively utilize known information to improve accuracy of assessment, when compared with the traditional methods. This is in fact an inevitable result, given the characteristics of the grey system theory. In this study, a multi-level comprehensive grey evaluation model is developed and applied in assessing the accreditation awarded by the SAS to the GDUFS.

**Model Specification**

The grey comprehensive evaluation is based primarily on the following model:

\[ R = E \times W \]

In the formula: \( R = [r_1, r_2, ..., r_m]^T \), represents the result vector of \( m \) objects in the comprehensive assessment.

\( W = [w_1, w_2, ..., w_n]^T \), represents the weight distribution vector of \( n \) assessment indicators, where \( \sum_{j=1}^{n} w_j = 1 \).

\( E \) represents the assessment matrix of these indicators:

\[
E = \begin{bmatrix}
\xi_1(1) & \xi_1(2) & \cdots & \xi_1(n) \\
\xi_2(1) & \xi_2(2) & \cdots & \xi_2(n) \\
\vdots & \vdots & \ddots & \vdots \\
\xi_m(1) & \xi_m(2) & \cdots & \xi_m(n)
\end{bmatrix}
\]
represents the correlation coefficient between the $k^{th}$ indicator and the $k^{th}$ optimal indicator in the $j^{th}$ scheme.

Next, the objects are sorted by the values of $R$.

(1) Ascertain the optimal indicator set ($F^*$).

Assume: $$F^* = [\hat{j}_1, \hat{j}_2, \ldots, \hat{j}_n]$$

In the formula, $\hat{j}_k (k=1,2,\cdots,n)$ represents the optimal value of the $k^{th}$ indicator. This value can be the optimal value among all schemes or the optimal value on which the assessors reach a consensus. In the case of the former, if it is better for the indicator to take a large value, the maximum among all schemes is selected. However, if it is better for the indicator to take a small value, the minimum among all schemes is selected. In the case of the latter, consideration should be given to advancement as well as feasibility. If the optimal value is set too high, it may be impractical and result in incorrect assessment.

After ascertaining the optimal indicator set, matrix $D$ is formatted as:

$$D = \begin{bmatrix} \hat{j}_1 & \hat{j}_1 & \cdots & \hat{j}_1 \\ \vdots & \vdots & \ddots & \vdots \\ \hat{j}_n & \hat{j}_n & \cdots & \hat{j}_n \end{bmatrix}$$

In this formula, $\hat{j}_k$ represents the original value of $k^{th}$ indicator in $j^{th}$ scheme.

(2) Standardize the indicator values.

Due to varying dimensions and magnitudes, assessment indicators cannot be compared directly. The original indicator values should be standardized to ensure correctness of assessment.

Assuming the variation section is $[\hat{j}_{11}, \hat{j}_{12}, \ldots, \hat{j}_{1n}]$, $\hat{j}_{1i}$ is the minimum of the $k^{th}$ indicator among all schemes, while $\hat{j}_{12}$ represents the maximum. From the formula below, the original value can be transferred to the dimensionless value $C_i^j \in (0,1)$:

$$C_i^j = \frac{\hat{j}_{1i} - \hat{j}_{12}}{\hat{j}_{12} - \hat{j}_{11}} \quad i = 1,2,\ldots,m; \quad k = 1,2,\ldots,n$$

In this way, matrix $D$ is transformed into matrix $C$:

$$C = \begin{bmatrix} C_1^1 & C_1^2 & \cdots & C_1^n \\ C_2^1 & C_2^2 & \cdots & C_2^n \\ \vdots & \vdots & \ddots & \vdots \\ C_m^1 & C_m^2 & \cdots & C_m^n \end{bmatrix}$$
(3) Retrieve the results of the comprehensive assessment calculation.

According to grey system theory, \( \{C\}=[C_1, C_2, \ldots, C_n] \) can be set as the referencing number series, and \( \{\xi\}=[\xi_1, \xi_2, \ldots, \xi_n] \) can be set as the referenced number series. With that, \( \xi(k) \) can be calculated. The correlation coefficient between the \( k \)th indicator and the \( n \)th optimal indicator in the \( l \)th scheme is as follows:

\[
\rho(k) = \frac{\min_{i} \min_{j} |C_i - C_j| + \rho \max_{i} \max_{j} |C_i - C_j|}{|C_i - C_j| + \rho \max_{i} \max_{j} |C_i - C_j|}
\]

In this formula \( \rho \in [0, 1] \), and this formula takes \( \rho = 0.5 \).

With the defined value of \( \xi(k) \), the value of \( E \) can be calculated. The assessment result is \( R = E \times W \), and therefore:

\[
r_l = \sum_{k=1}^{n} W(k) \times \xi(k)
\]

From the description of the multi-level grey assessment method above, it can be concluded that one of its greatest features is that it classifies the scattered information of different assessors into vectors of different grey clusters, and standardizes those vectors. Except in determining the grades of the assessment object, the results can also be used as the basis for the assessor to sort the values of different grey assessment objects at one time, and can provide suggestions for improving each indicator.

Results and Analysis

1. Determine the system of indicators

With reference to the assessment standards of the SAS and the method of educational quality assessment, this study establishes systems similar to those of the Department of Education in China, which are presented in Table 1. Based on Delphi’s adroit investigation method, selection of systematic indicators complies with the principles of hierarchy, applicability, and comparability. The system covers 6 first-class indicators, including institution and project management, faculty, students and schooling systems, curricula, objectives and results, as well as learning model and student participation. It also covers 29 second-class indicators, such as the institution characteristics and kernel system, faculty and teaching quality requirements, student enrolment and teaching systems, course teaching and internationalization, goal attainment and educational value added, as well as interdisciplinary studies and alumni associations.
<table>
<thead>
<tr>
<th>Catalogue</th>
<th>First-level Indicator</th>
<th>Second-level Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>Institution and Project Management</td>
<td>U11 Institutional Characteristics (vision, mission, etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U12 Internal and External Auditing Mechanisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U13 Institution Facilities and Resources</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U14 Project Management Mechanisms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U15 Project Managerial Personnel</td>
</tr>
<tr>
<td>U2</td>
<td>Faculty</td>
<td>U21 Quality Requirements for Faculty’s Teaching and Research</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U22 Faculty Scale and Sources</td>
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<tr>
<td></td>
<td></td>
<td>U23 A Combined System of Teaching and Research with Consulting Services</td>
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<td></td>
<td></td>
<td>U24 Faculty Development Policy</td>
</tr>
<tr>
<td>U3</td>
<td>Students and Schooling System</td>
<td>U31 Students’ Requirements and Sources</td>
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<td></td>
<td></td>
<td>U32 Enrolment Standards and Working Experience Requirement</td>
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<td></td>
<td></td>
<td>U33 Students’ Mutual Studying and Internationalization</td>
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<tr>
<td></td>
<td></td>
<td>U34 Schooling Standards and Study Time</td>
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<td></td>
<td></td>
<td>U35 Teaching Systems</td>
</tr>
<tr>
<td>U4</td>
<td>Curriculum</td>
<td>U41 Curriculum Content and Levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U42 Project Design and Internationalization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U43 Teaching and Studying Methods</td>
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<tr>
<td></td>
<td></td>
<td>U44 Studying of Management Skills</td>
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<tr>
<td></td>
<td></td>
<td>U45 Appraisal Systems and Feedback</td>
</tr>
<tr>
<td>U5</td>
<td>Objectives and Results</td>
<td>U51 Projects Objectives and Highlights</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U52 Objective Achievement and Achieving Methods</td>
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<tr>
<td></td>
<td></td>
<td>U53 Employer Expectation Levels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U54 Education’s Value Added</td>
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<tr>
<td>U6</td>
<td>Learning Model and Student Participation</td>
<td>U61 Classroom Learning and Online Learning</td>
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<td></td>
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<td>U62 Multi-disciplinary Learning</td>
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<td></td>
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<td>U63 Care and Support for Students</td>
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<td>U64 Alumni Associations</td>
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<td></td>
<td></td>
<td>U65 Continuing Education for Graduates</td>
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<tr>
<td></td>
<td></td>
<td>U66 Social Evaluation</td>
</tr>
</tbody>
</table>

Table 1. International Accreditation Indicator System of the SAS
2. Determine the weights

The weights are people’s judgments on the importance of a given indicator. These judgements are often affected by subjective factors and represent the quantization of a qualitative analysis. Different people tend to have different views on specific things. In their view, there are reasonable aspects as well as aspects biased by personal values, capabilities, and attitudes. Therefore, schemes that are put forward after coordinating the contradictions of assessors, as well as discussing, negotiating, and observing the various actual situations, are typically more convincing.

Based on the structure of the accreditation system of the SAS, a judgment matrix building on the analytic hierarchy process is established. The matrix has a scale of 1~9. Subsequently, the weight of each indicator is calculated by root methods. Taking relative weights of first-class indicators for objective U as an example, a judgment matrix $U=(b_{ij})_{6 \times 6}$ is formed as shown in Table 2. Then eigenvectors $W_U=(w_1, w_2, w_3, w_4, w_5, w_6)$ are calculated by root methods as well.

Given level structures, the judgment matrix is constructed on a 1~9 scale, and the weight of each evaluation indicator is calculated by the square root method.

<table>
<thead>
<tr>
<th></th>
<th>U1</th>
<th>U2</th>
<th>U3</th>
<th>U4</th>
<th>U5</th>
<th>U6</th>
<th>WU</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>1</td>
<td>1.3333</td>
<td>0.25</td>
<td>0.3333</td>
<td>0.5</td>
<td>0.25</td>
<td>0.0563</td>
</tr>
<tr>
<td>U2</td>
<td>3</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>2</td>
<td>0.3333</td>
<td>0.1288</td>
</tr>
<tr>
<td>U3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0.5</td>
<td>0.2295</td>
</tr>
<tr>
<td>U4</td>
<td>3</td>
<td>2</td>
<td>0.5</td>
<td>1</td>
<td>2</td>
<td>0.5</td>
<td>0.1737</td>
</tr>
<tr>
<td>U5</td>
<td>2</td>
<td>0.5</td>
<td>0.5</td>
<td>0.2</td>
<td>1</td>
<td>0.5</td>
<td>0.1023</td>
</tr>
<tr>
<td>U6</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0.3094</td>
</tr>
</tbody>
</table>

After a consistency test, $CR=0.032<0.1$, and $W_U=(0.0563, 0.1288, 0.2295, 0.1737, 0.1023, 0.3094)$, representing each first-class indicator’s relative weight vector for objective A. In the same way, relative weight for the second-class indicators for the corresponding first-class indicators is calculated. They are $W_t (t=1,2,3,4,5,6)$.

$W_1=(0.0816, 0.1341, 0.354, 0.177, 0.2533)$

$W_2=(0.1182, 0.1671, 0.2616, 0.4531)$

$W_3=(0.2727, 0.3762, 0.1906, 0.0765, 0.084)$

$W_4=(0.0749, 0.2195, 0.3525, 0.2195, 0.1336)$
W5= (0.01603, 0.0953, 0.2776, 0.4668)
W6=(0.0899, 0.1748, 0.0636, 0.2645, 0.1297, 0.2775)

The relative judgement matrices all pass the consistency test (CR1=0.025, CR2=0.026, CR3=0.057, CR4=0.013, CR5=0.012, CR6=0.017).

3. Determine the grey clusters

According to the actual requirements for the international accreditation of a business school, four grey clusters have been set after consulting experts: V={strong, semi-strong, medium, semi-weak}, and the corresponding grade set V=(9, 7, 5, 3). Four whitening weight functions are set as seen below.

\[ f_e(x) \begin{cases} \frac{1}{e}x, & x \in [0,9] \\ 1, & x \in [9,10] \end{cases}, \quad f_2(x) = \begin{cases} \frac{1}{2}x, & x \in [0,7] \\ 1, & x \in [7,10] \end{cases}, \quad f_3(x) = \begin{cases} \frac{1}{2}x, & x \in [0,5] \\ 2 - \frac{1}{2}x, & x \in [5,10] \end{cases}, \quad f_4(x) = \begin{cases} 1, & x \in [0,3] \\ 2 - \frac{1}{2}x, & x \in [3,6] \\ 0, & x \in [6,10] \end{cases} \]

4. Calculate the weight matrix of the grey assessment

Assuming \( d_k(w) \) is the assessment value of Ctk, with the first-level vector Ut (t=1,2,…,6), then the first-class indicator assessment matrix of Ut is, \( D_t= (d_k(w))_{t \times k} \). \( f_e(w) \) is the weight of \( w \) in the eth grey cluster. Additionally, \( r_c, r_p \) are the coefficients and general coefficient of Ctk, respectively.

\[ p^{(w)}_u = \sum_{k} f_e(w) \]

Assuming \( \tilde{r}^{(w)}_e \) as the expert assessment weight for Ctk, then:

\[ \tilde{r}^{(w)}_e = \frac{p^{(w)}_u}{p^{(w)}_i} \]

The weight of Ut (the tth first-class indicators, t=1,2,…,6) can form the grey assessment matrix \( R_t=(\tilde{r}^{(w)}_e)_{k \times i} \).

I. Determine the comprehensive assessment

First, assess the tth first-class indicator, and let the assessment vectors be Ut. Then Ut=Wt•Rt (t=1,2,…,6), and a grey assessment matrix for objective U is constructed:

\[ R= (U_1, \ldots, U_k)^T \]
Therefore, the comprehensive assessment vector of assessed teachers is:

\[ U = WU \cdot R \]

While the comprehensive assessment values are:

\[ U = WU \cdot R \]

A comprehensive assessment model is built to evaluate quality and satisfaction with the GDUFS BBA programme after its accreditation by the SAS. Questionnaires were sent to supervising departments, professors and experts, students, teachers, and employers to solicit their opinions on the programme. Then, a group of 10 experts was assigned to dig through the model’s files and score each indicator according to international accreditation standards. The scoring was conducted on a 10-point scale with a stage difference of 0.5. Taking U3 (Information Resources) as an example, the weight of each indicator is calculated based on assessment matrix D3, whitening weight function fe(x), and Formula (1), and matrix R3 is formed:

\[
R_3 = 
\begin{pmatrix}
0.4203 & 0.3979 & 0.1818 & 0.0 \\
0.4652 & 0.3870 & 0.1478 & 0.0 \\
0.2865 & 0.3610 & 0.3178 & 0.0347 \\
0.2865 & 0.3689 & 0.3267 & 0.0176 \\
0.2794 & 0.3592 & 0.3352 & 0.0262 \\
\end{pmatrix}
\]

According to Formula (2), the comprehensive assessment vector of the first-class indicator U3 is:

\[ U_3 = W_3 \cdot R_3 = (0.3897, 0.3813, 0.2189, 0.0102) \]

In the same way, the comprehensive assessment vectors can be calculated for U1, U2, …, U6. Then matrix R is formed based on Formula (3):

\[
R = 
\begin{pmatrix}
0.3902 & 0.3997 & 0.2073 & 0.0028 \\
0.2925 & 0.3413 & 0.2924 & 0.0738 \\
0.3897 & 0.3813 & 0.2189 & 0.0102 \\
0.3310 & 0.3691 & 0.2571 & 0.0428 \\
0.3706 & 0.4117 & 0.2177 & 0.0 \\
0.3750 & 0.3930 & 0.2320 & 0.0 \\
\end{pmatrix}
\]

If a maximum-weight principle is adhered to, the grey cluster is defined in the satisfied class. However, after calculating the assessment value W and whitening functions of each grey cluster, the grey clusters to which W belongs, based on maximum whitening weight, are defined. Thereafter, GDUFS BBA programme can be classified as semi-strong, according to the standards of the SAS.

According to Formula (4), the assessment vector of the GDUFS BBA program is:

\[ U = WU \cdot R = (0.3605, 0.3818, 0.2383, 0.0194). \]

According to Formula (5), the comprehensive assessment value Z is:

\[ Z = U \cdot V^T = 7.17 \]

Therefore, the overall assessment results in that the GDUFS BBA programme is
categorized as semi-strong. Experts and students have recognized this conclusion. The weight vectors of third-level indicators of the BBA programme at GDUFS, indicators including teaching material selection, teacher-student interaction, internal and external practice conditions, academic innovation and entrepreneurship, career guidance and services were below the standards of the SAS and had room for improvement. Indicators including teaching work ethics, quality of theoretical teaching, teachers’ practical skills, social practice, and volunteer service, on the other hand, exceeded the standards. This shows that aspects of the GDUFS BBA programme are recognized by experts as well as students and teachers.

Since the final results of the different assessment levels will be affected by maximum weight, the assessment results might be controlled by a single factor. As such, the whole assessment may be major-factor oriented, deviating from its comprehensive nature. The grey comprehensive evaluation method takes into equal consideration each sample’s effect on the final results as possible. Therefore, the results can theoretically conform better to the real nature of a research object. However, the results of fuzzy comprehensive assessment methods are in fact quantified grade remarks that cannot serve as the basis for sorting and selecting assessed objectives. That is a substantial disadvantage for this method.

The results of a grey comprehensive evaluation can not only be used to define the class of a single assessed objective, but can also provide the foundations for sorting and selecting among a group of assessed objectives. Referring to the accreditation system of the SAS, this report has constructed models and designed a study based on the GDUFS BBA programme with the adoption of a comprehensive assessment method building on the grey system theory. The results conform to the actual situation and can serve as a basis for future decision-making.

CONCLUSION

This research assessed the GDUFS BBA programme with reference to the international accreditation system of the SAS. During the entire process, it has gained great attention and support from the leadership of the university. The assessment results have proven to be in tune with the reality of the situation through communication with the university’s relevant departments, and will provide them with insight for improvement. Through the
research conducted in this paper, there is hope that advancing the cultivation of postgraduate education by international standards is promoted further. It is also hoped that this research may provide the basis for universities to improve their education and services, and encourage proper attitudes toward the professional postgraduate education of BBA students.

In the practice of educational assessment (such as school assessments, teaching assessments, academic achievement evaluations, competition evaluations, and students' moral assessments), a great number of assessment indicators should be taken into consideration. These systems of assessment indicators are usually multi-level, and are given corresponding weights. As such, the multi-level grey assessment method is widely applicable in this field. When used properly, it can more effectively utilize known information to improve the accuracy of assessment, when compared with traditional methods. This is in fact an inevitable result, given the characteristics of the grey system theory. Under certain circumstances, grey assessment methods can be applied together with fuzzy comprehensive evaluations, or other comprehensive assessment methods, to draw more reliable conclusions.

In educational assessment, there is a requirement to use a variety of quantitative tools, but these tools ought not be abused or solely relied on. Quantitative tools should be adopted based on qualitative ones, so as to study the relationships between the quality and quantity of systems with reference to their varying aspects. Quantitative tools should be adopted together with qualitative analysis. In the practice of educational assessment, the quality of systems of education ought to be investigated through initial qualitative analysis and only then be analysed via quantitative analysis. Finally, further research can be inducted and reveal quality on deeper levels, and thus make judgements and conclusions in line with the reality of a given situation.

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