# Dynamic Monitoring and Early Warning Mechanisms for the Employment Quality of University Graduates Based on Multi-Source Big Data

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**Abstract:** This article studies the employment quality of university graduates. Under the complicated and changeable background of the current employment situation, the research aims to build a real-time and dynamic employment quality monitoring system. By integrating the academic data on campus, the data on off-campus recruitment platform and the macro-industry data, drawing lessons from the analysis framework of large-scale Internet job hunting behavior, this article uses NLP (natural language processing) technology to analyze the job skills demand, and constructs a dynamic monitoring index and early warning model. Moreover, with the advantage of obtaining unique multi-dimensional data on campus, the feedback and intervention mechanism is put forward from the perspective of enrollment-training-employment linkage governance. The system can effectively monitor the change of employment quality, and the early warning model can detect potential risks in advance. This study provides a scientific basis for universities to optimize talent training strategies, adjust enrollment plans and enhance students' employment competitiveness, which is of great significance to improve the employment quality of university graduates.

## 1. Introduction

As an important reserve force of social talents, the employment quality of university graduates is not only related to personal career development, but also a key indicator to measure the fitness between the quality of college education and social and economic development [1]. Under the background of deep adjustment of economic structure and rapid technological changes, the employment market presents a complex and changeable situation. The traditional employment quality monitoring method based on limited samples and static data has been difficult to meet the needs of real-time and accurate grasp of employment dynamics [2-3]. In this case, building an efficient dynamic monitoring and early warning mechanism of employment quality with the help of multi-source big data has become an important issue to be solved urgently by universities and relevant departments [4].

The purpose of this study is to meet this challenge, focusing on how to organically integrate the academic data on campus, the data on off-campus recruitment platform and the macro-industry data, and build a real-time and dynamic employment quality monitoring system. Through this system, it is expected to achieve all-round and meticulous monitoring of the employment quality of university graduates, capture the subtle changes in the employment market in time, and provide scientific basis for the adjustment of talent training strategies, the optimization of enrollment plans and the employment guidance of students. In terms of methods, this study will learn from the large-scale Internet job-hunting behavior analysis framework, which is based on massive Internet job-hunting data and can effectively describe job seekers' behavior patterns and employment tendencies. Moreover, NLP technology is used to analyze job skills requirements, and key information is accurately extracted from complicated recruitment texts, which lays the foundation for building scientific and reasonable monitoring indicators and early warning models.

This study has unique advantages. On the one hand, rich and multi-dimensional data of students in school can be obtained, which provides detailed information for in-depth understanding of students' academic development and employability. On the other hand, from the governance perspective of enrollment-training-employment linkage, we not only pay attention to the monitoring

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and early warning of employment quality, but also pay more attention to the construction of feedback and intervention mechanism after early warning, and strive to form a closed-loop employment quality improvement system.

## 2. The application of multi-source big data

Multi-source big data brings a new opportunity for monitoring the employment quality of university graduates. Academic data on campus includes students' grades, course performance, academic achievements, etc. It comprehensively reflects students' knowledge mastery and academic ability, and is an important basis for evaluating students' employment competitiveness [5]. The data of off-campus recruitment platform, such as job description, salary and treatment, enterprise requirements, etc., directly show the demand of the job market and provide a window for universities to understand the market dynamics [6]. Macro industry data provides macro guidance for employment quality monitoring from the aspects of industrial development trend, total demand and structure of talents. The theory of big data analysis provides technical support for the integration and analysis of multi-source data, and can accurately describe the characteristics of the job market by mining the potential connections between data [7]. Relevant theories of employment quality, such as the theory of job matching and the theory of career development, make clear the direction for building a monitoring system and ensure that monitoring indicators and methods conform to the connotation and development law of employment quality.

## 3. Dynamic monitoring of employment quality based on multi-source big data

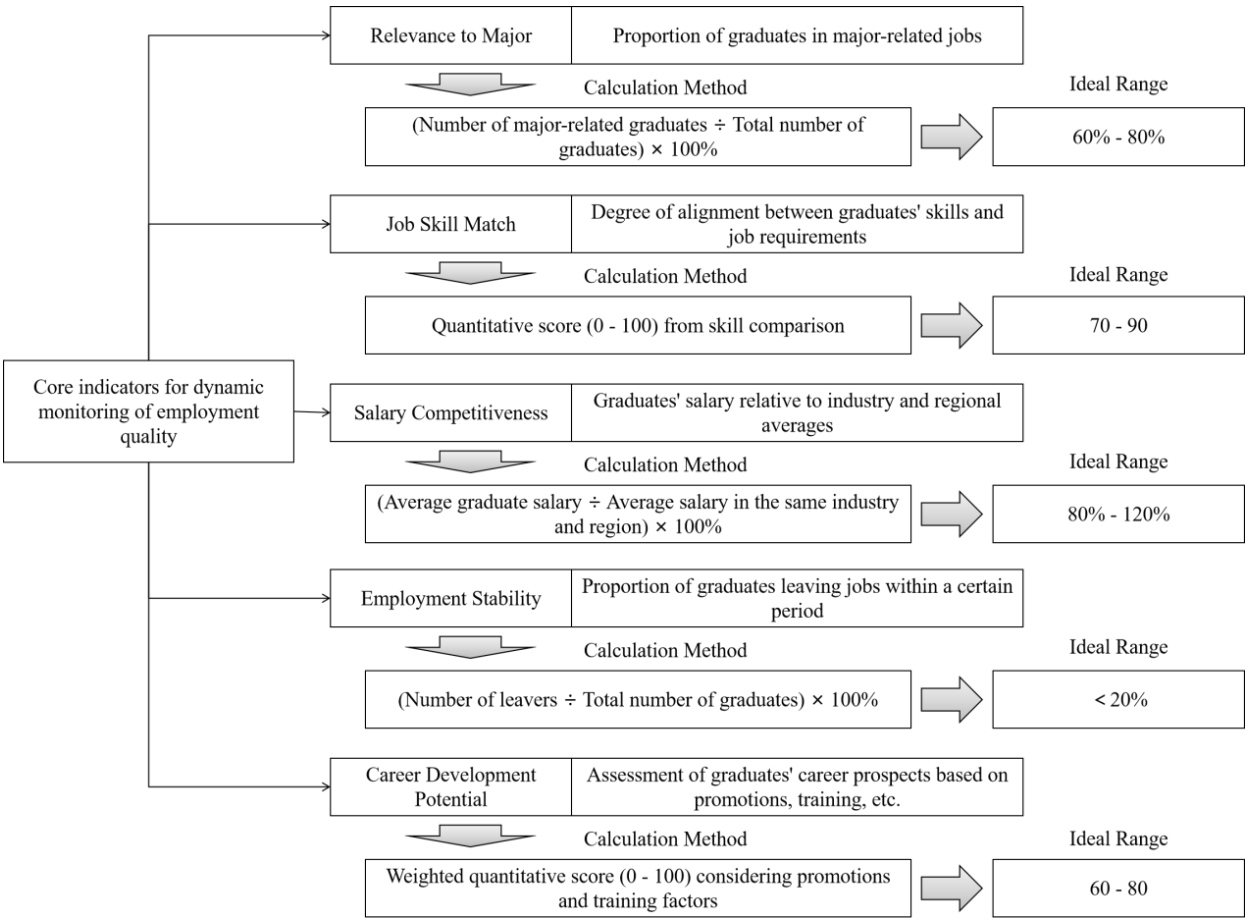


Figure 1 Core Indicators for Dynamic Monitoring of Employment Quality of University Graduates

To build a dynamic monitoring system of employment quality based on multi-source big data, it is necessary to comprehensively use a variety of technologies and methods to realize deep mining and analysis of all kinds of data. First of all, learn from the analysis framework of large-scale

Internet job hunting behavior. This framework can be compared to a precise "filter screen", which can screen out valuable information for monitoring the employment quality of university graduates from the massive data of job hunting behavior. Secondly, use NLP technology to analyze the job skills requirements. NLP technology, like a multilingual "translator", can transform the text in recruitment information into quantifiable and analyzable key skill points. In the construction of dynamic monitoring indicators, a series of core indicators are determined based on multi-source data and skills demand analysis results. As shown in Figure 1.

The specialty matching rate directly reflects the connection between specialty setting and market demand in universities. If the counterpart rate of a certain major continues to be low, it may imply that the training direction of this major is out of touch with the market demand. Job skill matching degree focuses on the fit between individual ability and job requirements, and high matching degree means that graduates can be better qualified for the job and improve employment stability [8]. Salary competitiveness reflects the employment quality of graduates from the economic level. The higher the salary, the higher the recognition of graduates in the job market.

## 4. Employment quality early warning model construction

The design idea of early warning model is based on the in-depth analysis of the changing trend of monitoring index data. Combining statistical methods with machine learning algorithms is like building a solid "data bridge" to connect historical data with future trend prediction. Statistical methods provide a basic tool such as average calculation, and the average formula is:

$$\bar{X} = \frac{1}{n}\sum_{i=1}^{n} X_i \tag{1}$$

Through this formula, we can calculate the average value of professional counterpart rate, job skill matching degree and other indicators in the past years. In this way, the centralized trend of these monitoring index data is described, and its overall level is preliminarily understood.

The correlation analysis formula is used to analyze the correlation between the professional counterpart rate, job skill matching and other indicators (X as variable) and the change of employment quality (Y as variable), and to clarify the close degree of correlation between each indicator and employment quality. The formula is as follows:

$$r = \frac{\sum_{i=1}^{n}(X_i-\bar{X})(Y_i-\bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i-\bar{X})^2 \sum_{i=1}^{n}(Y_i-\bar{Y})^2}} \tag{2}$$

Machine learning algorithm endows the model with the ability of self-learning and optimization. The model formula of linear regression algorithm is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \epsilon \tag{3}$$

In this formula, $X_1, X_2$, etc. represent various indicators such as professional counterpart rate and job skill matching degree, $Y$ represents the predicted employment quality, $X_1, X_2$ are coefficients, and $\epsilon$ is an error term. By constantly adjusting the coefficient $\beta$, the error between the predicted value and the actual value is minimized, so that the model can better adapt to the complex and changeable job market. Through the analysis of the employment data of graduates in the past years, the potential relationship between each index and the change of employment quality is excavated. When these indicators show a specific change pattern, the model can predict the possible risks of employment quality.

Model parameter setting and training is the core step to ensure the accuracy and reliability of early warning model. For different monitoring indicators, according to historical data and the actual situation of the job market, set a reasonable threshold range, as shown in Table 1:

Table 1 Key Parameter Settings for Employment Quality Early Warning Model

| Indicator Name | Lower Threshold | Upper Threshold | Weight | Related Indicators |
|---|---|---|---|---|
| Relevance Rate of Major to Job | 55% | 75% | 0.25 | Salary Competitiveness, Job Skill Match Degree |
| Job Skill Match Degree | 65 | 85 | 0.3 | Career Development Potential, Employment Stability |
| Salary Competitiveness | 75% | 115% | 0.2 | Relevance Rate of Major to Job, Employment Stability |
| Employment Stability | 15% | 25% | 0.15 | Job Skill Match Degree, Career Development Potential |
| Career Development Potential | 55 | 75 | 0.1 | Relevance Rate of Major to Job, Salary Competitiveness |

If the professional counterpart rate is lower than 60%, it indicates that the fit between major and employment may be too low, and there is a risk of declining employment quality; If it is higher than 80%, it means that the employment situation of this major is ideal. The threshold of job skill matching degree is set based on the basic and ideal requirements of the job for skills, while the threshold of salary competitiveness is set around the average salary level in the same industry and region. The weight distribution reflects the relative importance of each index in evaluating the quality of employment, and the job skill matching degree is given a higher weight because of its key influence on graduates' competence.

Use historical data to train and optimize the model. Through a large number of historical employment data input, the model constantly adjusts its internal parameters and optimizes the forecast results. In the training process, the prediction accuracy of the model is evaluated, and the deviation between the predicted value and the actual value is measured by MSE (Mean Square Error), as shown in Table 2.

Table 2 Evaluation of Model Training Prediction Accuracy

| Evaluation Round | MSE | Deviation Details | Retraining Required | Retraining Effect |
|---|---|---|---|---|
| 1 | 0.92 | Salary deviation 20%, relevance rate deviation 15%, match degree deviation 18% | Yes | Salary deviation reduced to 15%, relevance rate deviation reduced to 12%, match degree deviation reduced to 15% |
| 2 | 0.75 | Salary deviation 15%, relevance rate deviation 12%, match degree deviation 15% | Yes | Salary deviation reduced to 12%, relevance rate deviation reduced to 10%, match degree deviation reduced to 12% |
| 3 | 0.58 | Salary deviation 12%, relevance rate deviation 10%, match degree deviation 12% | Yes | Salary deviation reduced to 8%, relevance rate deviation reduced to 8%, match degree deviation reduced to 10% |
| 4 | 0.36 | Salary deviation 8%, relevance rate deviation 8%, match degree deviation 10% | Yes | Salary deviation reduced to 6%, relevance rate deviation reduced to 6%, match degree deviation reduced to 8% |
| 5 | 0.22 | Salary deviation 6%, relevance rate deviation 6%, match degree deviation 8% | No | - |

## 5. Feedback and intervention mechanism

It is a key link to improve the employment quality of university graduates to build a feedback and intervention mechanism based on the perspective of enrollment-training-employment linkage governance. It can make universities form an organic closed loop in the process of talent training and realize the coordinated development of all links. The feedback mechanism after early warning is like an information bridge, which transmits the early warning information of employment quality to the relevant departments of universities in a timely and accurate manner. When the employment quality early warning model signals, the information will be quickly fed back to the enrollment department, teaching units and employment guidance center. The enrollment department can learn about the demand of each major in the job market, the teaching unit can know the advantages and disadvantages of graduates in professional knowledge and skills, and the employment guidance center can grasp the common problems faced by students in the job search process.

From the aspect of enrollment, the intervention mechanism is embodied in the reasonable

adjustment of enrollment plan and specialty setting according to employment early warning. If the employment matching rate of a major is low for many years and the job skill matching degree is not ideal, the enrollment department should appropriately reduce the enrollment scale of the major or optimize the major direction. On the contrary, for majors with strong demand in the job market and high quality of employment, we can consider appropriately expanding enrollment. According to the development trend of the industry and the demand for new jobs, some forward-looking majors can be added to reserve strength for the future talent market.

In the training process, it is very important to adjust the curriculum system and practice teaching content according to the post skill demand. If the early warning information shows that the demand for specific skills in some positions is increasing, the teaching unit should integrate relevant contents into the curriculum in time to strengthen students' learning and training in these areas.

The intervention mechanism of employment links focuses on providing personalized assistance measures and employment guidance programs for students with employment difficulties. The employment guidance center can make one-to-one employment guidance plan for students according to their professional background, skill level and employment intention. For students with weak professional knowledge, organize targeted counseling courses; For students who lack practical experience, provide internship recommendations and practical opportunities.

## 6. Conclusions

Based on multi-source big data, this study constructs a dynamic monitoring and early warning mechanism for university graduates' employment quality, which provides innovative ideas and methods for college employment. By integrating multi-source data, this article breaks through the limitations of traditional monitoring methods and realizes all-round and real-time dynamic monitoring of employment quality. Drawing lessons from the analysis framework of large-scale Internet job hunting behavior and NLP technology, this article successfully constructs a scientific and reasonable monitoring index and early warning model, which can accurately describe the characteristics of the employment market and predict the employment quality risks in advance.

The feedback and intervention mechanism proposed in this article from the perspective of enrollment-training-employment linkage governance further improves the employment quality improvement system in universities. The enrollment link adjusts the plan and specialty setting according to the early warning to ensure that the student source structure adapts to the market demand; In the training process, courses and practical teaching should be optimized according to the job skills requirements to enhance students' employment competitiveness; The employment link provides personalized help for students with difficulties and improves the overall employment quality. Future research can focus on optimizing the model algorithm, improving its adaptability to the complex and changeable employment market, making the dynamic monitoring and early warning mechanism of employment quality more perfect, and providing more powerful support for the employment of university graduates.

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