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Big Data-Driven Transformation in Human Resource Management: Empowerment Paths of Data Mining Technology and Educational Innovation

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Abstract: *In the era of digital economy, enterprises are experiencing an explosion of data resources. This change has not only reshaped the market landscape but also posed new challenges and opportunities for human resource management (HRM). Traditional HRM models, relying on experience and qualitative analysis, struggle to cope with the "information overload" and "decision-making defocus" caused by massive heterogeneous data. Therefore, transforming these data into decision-driving factors has become a core proposition in modern management practice. This paper discusses how data mining technology, with its powerful data processing and analysis capabilities, serves as a key driver for HRM transformation. It delves into the dilemmas of traditional HRM, the applications of data mining technology in HRM, the transformation driven by this technology, challenges faced, and future directions. Moreover, it emphasizes the necessity of educational innovation in cultivating composite talents who understand both algorithmic logic and management practice.*

Keywords: *Big Data; Data Mining Technology; Human Resource Management; Educational Innovation; Decision-Making Rationality*

1. Introduction

In the wake of the digital economy, enterprises are facing an unprecedented explosion of data resources. This change has not only reshaped the market landscape but also presented brand-new challenges and opportunities for human resource management. [1]Traditional human resource management models, relying on empirical judgments and qualitative analyses, struggle to effectively cope with the issues of "information overload" and "decision-making defocus" caused by massive heterogeneous data. [2]Therefore, how to transform these data into productive factors that can drive decision-making has become a core proposition in modern management practice. Against this backdrop, data mining technology, with its powerful data processing and analysis capabilities, has gradually emerged as an important driving force for the transformation of human resource management.

2. Dilemmas of Traditional Human Resource Management Models

Traditional human resource management models have developed a relatively fixed system and methodology through long-term practice. However, as the market environment constantly changes and enterprise scales expand, this model has gradually exposed numerous shortcomings. Traditional human resource management decisions often rely on the experience and intuition of individual managers. Although this decision-making approach can reflect the professional judgment of managers to a certain extent, it lacks objectivity and scientific rigor. Especially when facing massive data, it is difficult to make comprehensive and accurate decisions solely based on personal experience. In terms of information processing, traditional human resource management models primarily rely on manual operations and simple data analysis tools. This processing method is not only inefficient but also fails to fully tap the potential value of data. As the amount of enterprise data continues to increase, these limitations become increasingly apparent, leading managers to often find themselves in a predicament of insufficient information when making decisions. Due to the lack of scientific data analysis and prediction capabilities in traditional human resource management models, the outcomes of decisions are often unpredictable. This not only increases the operational risks of enterprises but also affects their competitiveness. Especially in critical areas such as talent recruitment, training and development, and

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turnover prediction, the limitations of traditional models are particularly prominent.

3. Applications of Data Mining Technology in Human Resource Management

Data mining technology, as an advanced data analysis method, can extract valuable information from massive data through the construction of algorithmic models, providing a scientific basis for human resource management. [3]The following will detail the specific applications of data mining technology in human resource management. In terms of employee recruitment, the applications include:

(1) Recruitment Demand Forecasting

In the talent recruitment process, data mining technology can predict future recruitment needs by analyzing historical recruitment data. For example, manufacturing enterprises can adopt the ARIMA time series model to integrate dynamic data such as employee structure and department workload to construct a recruitment demand forecasting model. This model can accurately predict future recruitment needs, enabling enterprises to conduct talent pooling in advance and reduce recruitment costs.

(2) Intelligent Resume Screening

Resume screening is a crucial step in the recruitment process. Traditional manual screening methods are not only inefficient but also susceptible to subjective factors. Data mining technology, through the construction of an intelligent resume screening system, can achieve automatic classification and evaluation of resumes. [4] For instance, a BERT pre-trained model based on NLP technology can accurately identify key information in resumes and conduct quantitative evaluations. The application of this model not only improves screening efficiency but also reduces human interference, enhancing the fairness of recruitment.

(3) Career Path Planning

Career path planning is an important aspect of human resource management. Data mining technology, utilizing the Apriori association rule algorithm, can analyze employee performance and project participation data to discover key factors influencing employee promotions.[5] For example, by analyzing employee performance and project participation data, financial institutions have found that a feature combination of "project experience $\geqslant$3 times + cross-departmental collaboration $\geqslant$2 times" can increase promotion probability by 67%. Such discoveries provide a scientific basis for enterprises to formulate career path planning.

(4) Talent Digital Portrait Construction

A talent digital portrait is a talent assessment method based on big data. [6]Data mining technology, by employing the K-Means clustering algorithm, can analyze the behavioral data of top sales performers, extract core characteristics, and construct talent digital portraits. This type of portrait can comprehensively and objectively reflect employees' abilities and potential, providing strong support for enterprises to select outstanding talent. For example, by analyzing the behavioral data of top sales performers, retail enterprises have extracted core characteristics such as "customer response time $\leqslant$ 2 hours + service complaint rate $\leqslant$ 0.5%," shortening the new employee training cycle by 40%.

(5) Training Needs Identification

Identifying training needs is an important basis for enterprises to formulate training plans. Data mining technology, in combination with decision tree models, can analyze employee performance and training data to discover skill gaps among employees. For instance, manufacturing enterprises have found through the analysis of employee performance and training data that employees with a "device failure rate > 5% + training duration < 8 hours" have significant skill gaps. In response to this gap, enterprises can formulate targeted training plans to improve employees' skill levels.

(6) Turnover Risk Warning

Turnover risk warning is an important means for enterprises to prevent talent loss. Data mining technology, by integrating multiple indicators to construct a random forest model, can identify high-risk turnover personnel in advance. For example, technology companies have used a turnover risk warning system to identify high-risk turnover personnel three months in advance and taken corresponding measures to retain them, increasing the retention success rate to 76%. The application of

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this warning system provides strong support for enterprises to reduce talent turnover rates.

4. Transformation of Human Resource Management Driven by Data Mining Technology

The application of data mining technology in human resource management has not only improved the efficiency and accuracy of human resource management but also driven changes in human resource management models.[7] The application of data mining technology has shifted human resource management decisions from being based on empirical intuition to being data-driven and rational. By constructing algorithm models, data mining technology enables rapid analysis and processing of massive amounts of data, providing a scientific basis for decision-makers. This shift in decision-making not only improves the accuracy and efficiency of decisions but also reduces decision-making risks.

The application of data mining technology has promoted innovation in human resource management models. By constructing talent digital portraits, training needs identification models, and so on, data mining technology enables comprehensive and objective assessment and prediction of talent. The application of these assessment and prediction results enables enterprises to formulate more scientific and reasonable human resource management strategies. For example, enterprises can select outstanding talent based on talent digital portraits and develop training plans based on training needs identification models. This innovation in management models not only improves the effectiveness of human resource management but also promotes the sustained development of enterprises.

In response to the demand for digital transformation, human resource management teaching urgently needs to reconstruct its knowledge system and practical paradigm. [8]The curriculum system should establish a three-level module of "basic theory - core technology - scenario application," covering both underlying knowledge such as statistical principles and database management and technical tools such as Python data analysis and machine learning algorithms, ultimately focusing on practical fields such as human resource data analysis and organizational network analysis. Practical teaching needs to design full-flow projects, such as using the Scrapy framework to crawl data from recruitment websites, performing feature engineering processing with Pandas, building predictive models with Scikit-learn, and using Tableau for result visualization. This reconstruction of the teaching system aims to cultivate compound talents who understand both algorithmic logic and management practices, providing intellectual support for the transformation of human resource management.

5. Challenges Faced by Data Mining Technology in Human Resource Management and Future Development Directions

Despite the tremendous potential and value demonstrated by data mining technology in human resource management, its application still faces numerous challenges. The following will provide a detailed introduction to these challenges as well as future development directions.

Data privacy protection is a significant challenge in the application of data mining technology in human resource management.[9] Due to the involvement of a large amount of sensitive information in human resource management, such as employee personal information and salary data, ensuring the security and privacy of this information has become an urgent issue to be addressed. In the future, a federated learning framework should be developed to enable cross-organizational data collaboration, and a dedicated pre-trained language model for the HR field should be constructed to ensure the security and privacy of data during transmission and storage.

The scarcity of compound teachers is a key factor restricting the application of data mining technology in human resource management. Since data mining technology involves knowledge and skills from multiple disciplines, such as statistics, machine learning, and human resource management, cultivating compound talents who understand both algorithmic logic and management practices has become a priority. In the future, cooperation and exchanges with universities and research institutions should be strengthened, and talented individuals with interdisciplinary backgrounds should be introduced to build a high-quality and professional teaching staff.

Model interpretability is one of the important challenges in the application of data mining technology in human resource management. Due to the complexity and difficulty of intuitive understanding of the algorithm models constructed by data mining technology, it is challenging for managers to fully trust the model results when making decisions. In the future, ethical guidelines for assessing the impact of algorithms should be established to improve the interpretability and

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transparency of models, enabling managers to more intuitively understand the model results and make scientific decisions.

The promotion of low-code analysis platforms is one of the future development directions for the application of data mining technology in human resource management. Since data mining technology involves complex programming and algorithm design, many managers find it difficult to directly apply this technology for data analysis and decision-making. In the future, low-code analysis platforms should be promoted to lower the technical threshold and operational difficulty of data mining technology, enabling more managers to easily use this technology for data analysis and decision-making.

6. Teaching Innovation and Practical Application

In terms of curriculum system construction, human resource management teaching should keep up with the development trend of data mining technology and establish a three-level module of "basic theory - core technology - scenario application". The basic theory module covers fundamental knowledge such as statistical principles and database management, laying a solid theoretical foundation for students. The core technology module includes technical tools such as Python data analysis and machine learning algorithms, enabling students to master the core skills of data mining. The scenario application module focuses on practical fields such as human resource data analysis and organizational network analysis, enhancing students' practical abilities through case analysis, project practice, and other methods.

Practical teaching is an indispensable part of human resource management teaching. In order to cultivate students' practical abilities and innovative thinking, full-process practical teaching projects should be designed. For example, students can use the Scrapy framework to crawl data from recruitment websites, process feature engineering through Pandas, build prediction models with Scikit-learn, and visualize the results using Tableau. Such projects not only allow students to become familiar with the operational procedures of data mining technology but also exercise their data analysis and visualization abilities.

In addition, practical teaching projects can be carried out in cooperation with enterprises. By participating in real human resource management projects in enterprises, students can gain an in-depth understanding of the practical application of data mining technology in enterprises and discover and solve problems in practice. This cooperation method can not only improve students' practical abilities but also bring actual benefits and value to enterprises.

In order to ensure the effective implementation of data mining technology in human resource management teaching, it is necessary to strengthen teacher training and team building. On the one hand, teachers should be organized to participate in relevant training courses and seminars to improve their data mining technology and teaching abilities. On the other hand, excellent talents with interdisciplinary backgrounds should be actively introduced to build a high-quality and professional teaching staff. At the same time, internal communication and cooperation within the team should be strengthened to form a good atmosphere of complementary advantages and collaborative innovation.

Teaching effect evaluation is an important part of ensuring teaching quality. In order to evaluate the implementation effect of data mining technology in human resource management teaching, a scientific teaching effect evaluation system needs to be established. This system should include student satisfaction surveys, course grade analysis, practical project achievement displays, and other aspects. By collecting and analyzing these data, the problems and difficulties of students in the learning process can be understood, so that teaching strategies and methods can be adjusted in a timely manner. At the same time, a feedback mechanism can also be established to encourage students and teachers to provide opinions and suggestions, providing strong support for teaching improvement.

7. Conclusion and Outlook

The human resource management revolution driven by big data is profoundly changing the landscape and model of human resource management. [10]As an important technical support, data mining technology provides scientific and efficient decision-making basis and means for human resource management. By constructing algorithm models and achieving data-driven decision-making, data mining technology can significantly improve the efficiency and accuracy of human resource

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management. At the same time, teaching innovation and practical application also provide strong support for cultivating human resource management talents who can adapt to the digital era.

However, the application of data mining technology in human resource management still faces many challenges. In the future, it is necessary to continue strengthening technology research and innovation, improving data privacy protection, cultivating composite teaching staff, and enhancing model interpretability. At the same time, promoting low-code analysis platforms and strengthening cooperation and exchanges between universities and enterprises are also important development directions in the future. Through these efforts, we can further promote the in-depth transformation of human resource management driven by big data, providing powerful talent guarantee and support for the sustainable development of enterprises.

With the continuous advancement of technology and the continuous expansion of application scenarios, the potential and value of data mining technology in human resource management will be further explored and released. We have reason to believe that in future development, data mining technology will become one of the indispensable important tools and methods in the field of human resource management. At the same time, teaching innovation and practical application will continue to contribute to cultivating more excellent human resource management talents.

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