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The Application of Bayesian Network Deep Learning to The Assessment of Human Resource Efficiency Using Massive Data

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Abstract

The importance of human resource management in helping businesses plan for the future and increase their competitiveness cannot be overstated. Due to its inherent limitations and lack of objectivity, the traditional human resource performance appraisal model has historically struggled to keep up with the highly integrated development needs of today's enterprises as they've emerged in response to the advent of new technologies like the knowledge economy and big data. Therefore, the purpose of this research is to serve as a theoretical guide for contemporary business human resource management by advancing the study of a human resource performance assessment model based on Bayesian networks using big data analysis and cutting-edge technology methods. To begin, it provideda high-level overview of performance appraisal and its central role in enterprise management; then, it delved into the specifics of human resources performance appraisal indices and the connections between them; and finally, it detailed the fundamentals of putting together a performance appraisal system. Second, it suggested a performance assessment model based on Bayesian networks to meet the requirements of corporate human resources management, summarizing the relevant theory of Bayesian networks and their benefits in handling complicated random issues. Finally, a performance assessment system was constructed using the balanced scorecard approach, and the performance appraisal model suggested in this research was experimentally evaluated and compared to the conventional method.This paper's findings demonstrated that the suggested performance evaluation model offered substantial benefits and could be more effectively applied to the performance assessment management of business human resources. This paper's findings have applications beyond only business human resource allocation and management; they may also be used as a benchmark in the evaluation of performance in other areas.

Keywords: Deep Learning, Human Resource, Bayesian Network

INTRODUCTION

Human resources are becoming more important to a company's success in today's rapidly evolving economic, scientific, and technological landscape. As the information economy has rapidly grown, human resources have consistently surpassed all others in terms of competitiveness and creativity. It may help firms stay competitive and perhaps have an impact on their expansion strategies. Human resources, in contrast to more traditional forms of capital, are both dynamic and unique (Shen, 2020). As a result, businesses typically give human resource management priority. The management of human resources is similar to the management of production, operations, and finances. Human resource performance assessment has a substantial impact on how efficiently and effectively firms function. Organizations may better deploy human resources, create growth strategies, and boost their competitiveness by gaining a real-time understanding of their employees' working circumstances and contributions. To understand whether or not employees are on track to meet their work goals, human resource performance assessment management (Luo, Xing, and Ren 2022; L. L. Zhou, Ma, and Li 2020) focuses on conducting frequent evaluations based on the enterprise's development goals. Assessing employee performance has the ability to fine-tune the business's production and operation management

strategy, tap into the full potential and passion of its workforce, and propel the company toward its ultimate goal. With the advent of the big data era, the traditional static management style of modern enterprises has given way to the dynamic and methodical management of human resources.

Employee performance in conventional businesses is often managed in accordance with the separation of duties across several departments (L. T. Zhou, Wu, & Chen, 2022). Due to the unique characteristics and future ambitions of each organization, it is now more important than ever to implement a systematic approach to evaluating employees' contributions to the company's success. As a result, it is difficult forthe results of employee performance appraisals to provide a scientific basis for enterprise adjustment and development strategy, despite the fact that they can reflect the primary responsibility of employees in the department. And it is difficult to achieve the goals of modern corporate management and development using the traditional performance evaluation paradigm, which puts departmental interests first and lacks integrity (Wang, Yuan, and Elhoseny 2019). The purpose of a performance review is to evaluate an employee's contribution to the company as a whole and to reward hard work. The relevance of performance assessment results and organizations' continued progress can only be supported by adopting modern and scientific methods of human resource performance evaluation. Therefore, this paper provides a theoretical reference for current corporate human resource management by exploring a Bayesian network-based performance evaluation model for human resources.

Review of Literature

A group of academics proposed human resource management and performance evaluation in the 1970s. The importance of human resource management in businesses has grown with the economy and society,and performance assessment has evolved to become an integral aspect of HRM (Goes and Oliveira,2020). Some early researchers have achieved considerable advances in the field of performance assessment and management through experience and the development of a set of related ideas. Incentive theories, such as the cognitive assessment approach, the objective management method, and the fair management method, have been proposed by many individuals. Some academics in recent years have proposed new ways to construct the performance evaluation system and enhanced the current performance management approaches by drawing on incentive theory. Such approaches include the balanced scorecard, whole view, and key indicator assessment models (Lidinska and Jablonsky, 2018; Zhao et al., 2021). The balanced scorecard approach is one such framework, and it works by first categorizing the many aspects of performance into several dimensions based on the primary factors that influence performance and then further subdividing each dimension into multiple assessment indicators. Employees are evaluated based on how well they measure up against a set of criteria known as "key indices," which are determined by doing research into the most important aspects influencing performance.

Human resource management is a crucial component of every successful business, and it relies heavily on cutting-edge scientific methods in order to properly allocate and organize staff, maximize thecontributions of motivated workers, and ensure the company's growth and success. Human resource management's objective is to ensure harmony in the workplace by facilitating communication and cooperation among workers, establishing systems to ensure tasks are completed efficiently, balancing individual interests with those of the business, fully mobilizing employees' working abilities, and providing solid support for the achievement of the enterprise's goals. Personnel management in businessesis getting more intricate as a result of the emergence of contemporary science and information technology. The demands of contemporary people management cannot be met by the manual techniques upon which conventional human resource management is founded. Some have started using big data and information technology to carry out human resources management in an effort to boost the degree of scientific decision-making inside businesses (Hu and Zhao 2020; Zhao, Ding, and Wang 2020). For instance, a scientific human resource performance evaluation system can be developed by developing a number of different human resource management information systems and then applying them in an efficient mannerto enterprise personnel management. This will not only improve management efficiency with the full assistance of computer technology but will also accurately analyze the data in human resource management.

Workers are crucial to the success and growth of businesses since they are both their primary source of production and their managers. In light of this, HR performance management is crucial to the growth ofboth workers and businesses. Based on the findings, it is possible to maximize the talents of each personvia objective performance reviews and to tailor management strategies to each employee's skill set. The outcomes of performance evaluations may encourage

workers to accomplish their tasks successfully and contribute to optimizing the use of human resources. As a result, many studies have been conducted on the subject of creating performance evaluation systems. As big data and computing power continue to advance at a fast pace, businesses are making the transition to informational production management. Enterprise resource planning (ERP) is one such example that has become indispensable in many businesses (Sohail et al., 2021). Some domestic businesses, however, remain stuck in the past when it comes to human resource management, and only the most antiquated techniques are used when it comes to evaluating workers' productivity. Most businesses nowadays have adopted a highly technological approach to production management. Therefore, it is crucial that the performance assessment process be included in the information integration and management platform as soon as feasible, given its significance in human resource management. Developing an effective performance appraisal system through the application of new technologies or methods is not only an urgent problem for enterprises to solve under the new situation, but it also provides powerful guidance for enterprises to formulate development strategies. This is because the traditional performance appraisal model lacks a certain objectivity and scientificity.

Human resource management is essential in assisting businesses with the formulation of development plans and the enhancement of competitiveness (Zhao et al., 2021). Traditional human resource performance assessment approaches may not be objective enough to fulfill the highly integrated development demands of contemporary organizations, especially in light of the knowledge economy and big data's explosive growth. In light of this, this study suggests a novel method for gauging the effectiveness of human resources, one that makes use of Bayesian network analysis and other cutting-edge technological tools. The objective is to provide conceptual principles for contemporary HRM in organizations.

The paper first provides an overview of performance appraisal and its significance in enterprise management. It then analyzes the characteristics of human resources performance appraisal indicators and their relationships, as well as the common methods and characteristics needed to build a performance appraisal system. Next, the paper explores the relevance theory of Bayesian networks and their advantages in solving complex random problems. Based on this theory, the paper proposes a performance appraisal model for the needs of enterprise human resources management.

To test the effectiveness of the proposed model, the paper uses the balanced scorecard method to build a performance appraisal system and conducts experiments to compare the proposed model with traditional methods. The results demonstrate that the proposed model has significant advantages in terms of objectivity and adaptability and can be better applied to the performance appraisal management of enterprise human resources.

Overall, the research in this paper highlights the importance of using new technologies such as big data analysis and Bayesian networks to improve the objectivity and adaptability of traditional performance appraisal models. The paper also contributes to the advancement of human resource management in modern enterprises by providing theoretical guidance for further research on enterprise human resource allocation and management.

Methodological Tools Administered

Performance Appraisal and Related Theoretical Basis Performance Appraisal Concept

An important mechanism for personnel management and benefit tracking control in enterprise management is the performance evaluation system, which provides a solid foundation for human resources management and decision-making in the enterprise's HR division. Without a flawless performance management system, an organization may not be able to carry out its management functions as usual or achieve its production management goals (Li and Pahlevanzadeh, 2022). Figure 1 depicts the importance of performance evaluation in company human resource management and the connections between evaluation and other tasks.

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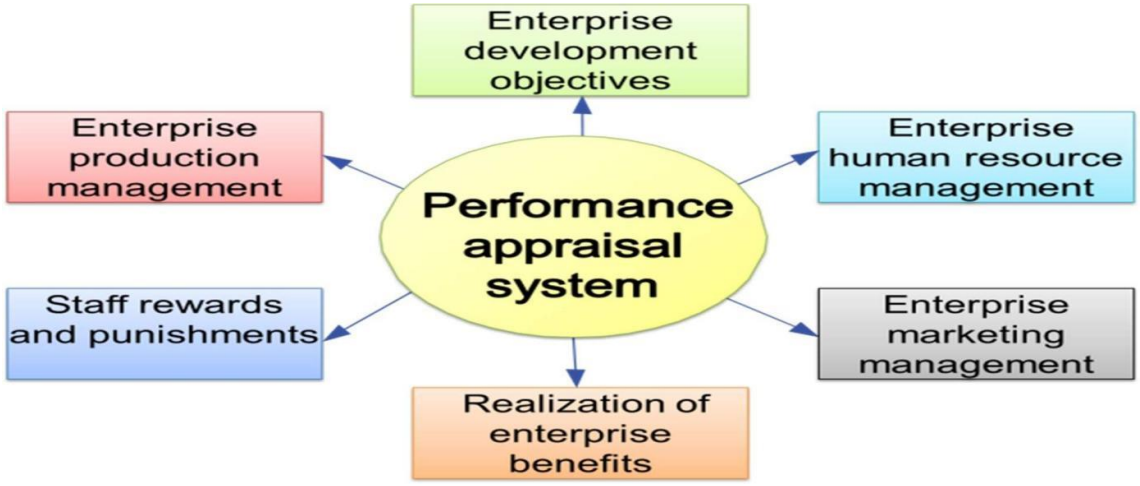
Figure 1

A simplified representation of performance evaluation's function in corporate management.



The word "performance" is used to describe the resultant function or efficiency once a job has been completed or an objective has been met. What individuals put in to accomplish the outcome is what we call performance. The efficiency and effectiveness of a company's workforce is an illustration of itsperformance. Human resource performance management at the enterprise level is predicated on the idea that people's actions and outcomes can be evaluated objectively. Persons' performance should be evaluated based on both input (what a person does) and output (what that individual produces), since behavior is the product of an individual's mental and physical labor (Goes and Oliveira, 2020). Appraisal of performance is another name for it. In order to effectively promote the development of the enterprise and the realization of its objectives, it primarily adopts certain appraisal standards and methods to comprehensively evaluate the employees of the enterprise, so as to understand their status and formulate corresponding rectification measures according to the appraisal results. The outcomes of an organization's performance assessment are reflected in a performance review, which is used to provide timely feedback on an employee's performance both inside their department and throughout the organization. We will continuously boost enterprise personnel's job enthusiasm and relevancy via performance assessment. To guarantee the findings of an assessment are fair, unbiased, and taken seriously, a performance appraisal must adhere to the key concepts of paying attention to personal performance, scientific and objective principles, timeliness, and continuity (Nasar et al., 2021).

Performance Appraisal Indicators

Enterprises need a fully functional performance assessment system to conduct scientific and objective evaluations of employee performance. Since performance reviews are so intrinsically linked to businesses achieving their growth goals, designing an effective performance review system necessitates taking into account both the enterprise's current state and its desired future state. The morale of workers and the productivity of the business would suffer if the existing assessment system was unable to accurately reflect an objective appraisal of its personnel. The concepts of objectivity, measurableness, honesty, consistency, and cost-effectiveness should guide the development of the performance evaluation system (Alsaleh et al., 2020).

The construction principles of the performance appraisal system and the design of relevant indicators are generally consistent across organizations, despite differences in specific situations such as the departments, positions, and work nature of employees and the appraisal indicators (Chiang and Lin, 2020). The appraisal index is a key indicator of the effectiveness of the performance assessment system asa whole, serving as the primary basis for assessing employee performance. The assessment index servesas a compass to direct workers' demeanor and performance on the job, making its establishment a matter of critical strategic importance to the corporate performance appraisal system as a whole. The majority ofa performance review will consist of either a qualitative or quantitative component. There are both qualitative and quantitative indicators included in the assessment criteria. Employees' work processes are often

evaluated using qualitative indicators, while their performance is evaluated using quantitative ones. When designing evaluation indicators for use in a company's performance appraisal system, it's important to keep objectivity and practicality in mind, as well as take into account the company's stage of development and the state of affairs in the marketplace (Luo, Xing, and Ren 2022).

Each assessment index has to have a weight assigned to it in the developed performance appraisal system. As a result, standard approaches to establishing weights may be used. These include the expert scoring technique, the analytic hierarchy procedure, and the subjective assessment method. The analytic hierarchy process (AHP), which requires less labor and is more scientific, may be used to assign weights to each assessment indicator in a transparent and objective manner (Nasar et al., 2021). In order to build the weight matrix for each indication, this technique relies first on obtaining the relative weights of each indicator based on expert assessment and then on statistical methods for analyzing the evaluation findings. The relative importance of each indication is then calculated by inspecting the weight matrix. The findings achieved via the analytic hierarchy approach are generally objective since it not only uses the outcomes of the expert review but also uses scientific computation and analysis (Atienza, Bielza, and Larranaga 2022). Following the analytical hierarchy method, the relative weight matrix of the indices is as follows:

$$R = \left[\begin{array}{c|ccc} r_1 & r_{11} & r_{12} & \cdots & r_{1m} \\ r_2 & r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ r_m & r_{m1} & r_{m2} & \cdots & r_{mm} \end{array}\right] \quad (1)$$

Each cell's relative weight in the judgment matrix represents the outcome of an expert's assessment based on a set of predefined criteria. The above judgment matrix's element Rij reflects the relative importance of the index Ri with regard to the other indices Rj. There are often numerous tiers to the relative weight value of each indication, with each tier representing a different degree of significance.

The following statement is true for every judgment matrix, since the weight value Rji of Rj in relation to Ri is exactly the reciprocal of Rij.

$$r_{ij} = \begin{cases} \frac{1}{r_{ji}} i, j \in [1, m], i \neq j \\ 1 i = j \end{cases} \quad (2)$$

It is important to execute additional appropriate processing on the judgment matrix in order to retrieve the weight values of each indication in the performance assessment system, since the components in the judgment matrix are merely the relative weight values of each indicator.

In the first step, the normalizing technique is applied to the R > 0 judgment matrix. The precise formula for the computation is as follows:

$$r'_{ij} = \frac{r_{ij}}{\sum_{k=1}^{m} r_{kj}} \quad (3)$$

Then, we add, row by row, each component of the normalized judgment matrix R:

$$r_i = \sum_{j=1}^{m} r'_{ij} \quad (4)$$

The relative weight wi of each indication may then be determined using the aforementioned data. The precise formula for the computation is as follows:

$$w_i = \frac{r_i}{\sum_{k=1}^{m} r_k} \quad (5)$$

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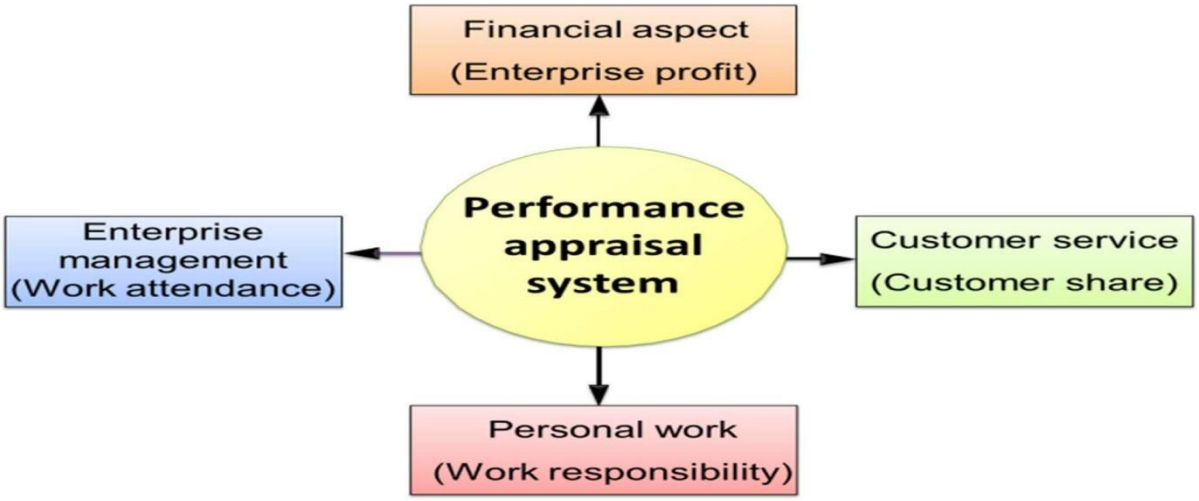
Common Methods of Performance Appraisal

Adopting suitable methodologies to measure performance is essential to ensuring that corporate performance evaluation can accomplish its intended goals. These include the objective management approach, the use of key performance indicators (KPIs), the balanced scorecard, and the comprehensive perspective assessment approach (Atienza, Larranaga, and Bielza 2022). The goal of every company's performance assessment process— regardless of how it's implemented— is to increase both employee engagement and the company's bottom line.

Management by objectives is a style of performance evaluation in which managers and workers set goals for their work in line with the overall vision for the company's growth and success; progress toward these goals is monitored on a regular basis. Goal-setting helps workers see where their efforts are going and allows managers to assess how well they're doing against predetermined standards. Management by objectives necessitates breaking down the overarching goals of business growth into more manageable chunks and assigning those chunks to various levels of management and frontline workers. The next step is to conduct frequent assessments of the specified job goals of staff at all levels, to evaluate the work completion status of relevant departments and personnel, and to use this information as the foundation for rewarding or disciplining workers (Lidinska and Jablonsky, 2018). When using the objective management approach to evaluating performance, managers and workers at all levels should set goals that are constantly updated in response to changes in corporate development objectives. That's why this strategy lends itself well to widespread implementation across industries. The stability and sustainability of the enterprise-wide performance appraisal may be compromised when the objective management approach is used, as the objectives may need to be continuously adjusted to ensure that the enterprise's development remains on schedule and without compromising its integrity.

Figure 2

A balanced scorecard's importance in developing a framework for evaluating employee performance.



The balanced scorecard is an alternative to the traditional method of performance evaluation based on financial indicators. It focuses on four key areas: the financial health of the business, customer satisfaction, internal management, and technological advancement. Figure 2 depicts the detailed structure of the evaluation process. The balanced scorecard is able to strike a good balance between different indicators since it considers both the short-term and long-term goals of business growth.

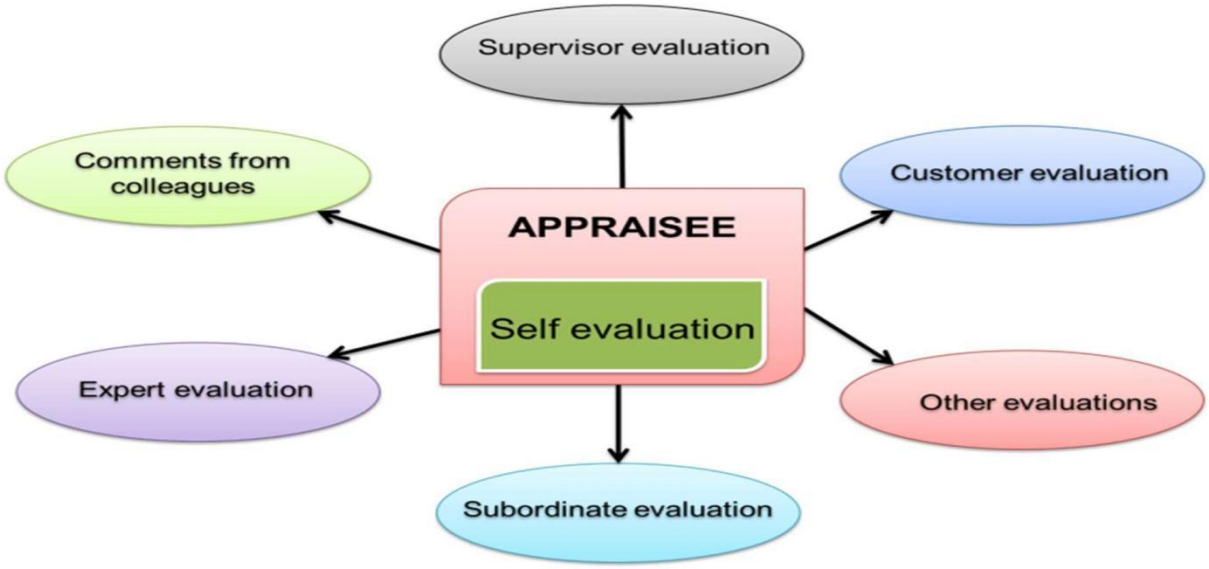
Employee performance evaluation goals must be established across four dimensions in accordance with the corporate growth strategy as part of the balanced scorecard implementation process. We need to establish the connection between employee performance and evaluation outcomes, as well as the interaction between distinct assessment indicators, when we design these outcomes. Meanwhile, irregular assessment findings will be used to dynamically change unreasonable assessment indicators. By eliminating the drawbacks of more conventional evaluation techniques, the balanced scorecard also motivates workers to more closely align their efforts with the goals of the business. It might be

challenging to utilize the balanced scorecard for performance evaluation since it requires consideration of so many different elements, including the company's growth plan, finances, and employees.

Human resource performance characteristics analysis, indicator mining, and model construction are the cornerstones of the key performance indicator assessment approach. This technique uses the main indicators as the benchmark for assessment and develops a correlation between those indications and an employee's performance. Goal composition is used to construct the key indicators of each department based on the corporate development objectives, and the indicators of each department are further broken down into the key indicators needed for employee evaluation. When evaluating an employee's performance, it's important to first establish how each indication will be weighted and how it will be scored, then evaluate how well workers have completed tasks to the standards set by key indicators, and then get the performance assessment findings for each employee. To be effective, the performance assessment system built using this approach must be based on predetermined key indicators, with the significance of an indicator's influence on the achievement of business goals serving as the criterion by mwhich it is defined (Wang, Yuan, & Elhoseny 2019). As a result, there are constraints on where this technique may be used.

Figure 3

Conceptualization of the Complete Perspective Evaluation Procedure.



Employee performance is evaluated from several angles in order to get more accurate assessment results using the complete perspective assessment approach (Scanagatta et al., 2018). Figure 3 shows a simplified flowchart of the whole perspective evaluation procedure. The assessment team's goals should be crystal clear before beginning the complete perspective assessment technique. Its members need expertise in the items being evaluated in order to provide each member with a unique score. Second, everyone in the team reviews workers fairly and consistently with the criteria for evaluation. Employees are finally evaluated thoroughly based on the aggregated feedback of all assessment panelists. The examinees may verify their task completion more thoroughly based on the evaluation findings of each team member, and the procedure can prevent the unfairness of conventional assessment methods. There are many subjective aspects to the assessment findings, which makes it hard to promote the approach in practical application. The method also needs more people to be involved in the performance review, which increases theburden.

The suggested technique for evaluating human resource performance using Bayesian network analysis and the balanced scorecard method has broad potential for use in other areas of research as well. Employees' performance in other departments, including marketing, finance, or operations, might also be measured using this approach. One major benefit of the suggested approach is that it may be used tobetter manage human resources by rooting out biases in the performance review process. This method might be used in various fields to root out biases and provide better methods of allocating resources and maximizing output. The suggested approach can be generalized to other domains,

although it may need tobe tweaked to meet the requirements of those other domains. This may require making changes to the performance evaluation criteria, the Bayesian network analysis, or adopting other methods entirely. We conclude that the suggested approach may be generalized well beyond HRM into other relevant scientific fields. We can learn more about performance assessment and how it might be adapted to the demands of contemporary businesses if we use cutting-edge statistical analytic methods and cutting- edge technological tools. We invite scholars to consider how this approach may be used in their respective domains, keeping in mind that certain modifications may be necessary.

Human Resource Performance Appraisal Model Based on Bayesian Network

Here, we suggest a fresh method for gauging the effectiveness of human resources, one that makes use of cutting-edge statistical methods and technological innovations. Bayesian network analysis and the balanced scorecard approach are the foundation of the suggested technique for creating an evaluation of performance. This work makes a significant contribution by showing how modern methods of statistical analysis may be utilized to make more objective and flexible the conventional models for evaluating employee performance within the field of human resource management. We demonstrate how the suggested approach might reveal biases in the evaluation procedure and provide advice on how to makethe procedure more fair and accurate. We can learn more about the performance evaluation procedure and how it might be enhanced by using cutting-edge statistical analytic techniques. Better strategies for managing human resources in 21st-century businesses may be developed after hidden patterns in the data set are uncovered. In sum, the work presented here advances the state of the art in human resource management. Improve the performance review process to match the demands of contemporary businesses by using cutting-edge statistical analytic methods and technological advances. We anticipate that this document will be useful to those doing studies and conducting actual HRM practices.

Overview of Bayesian Networks (BN)

As a typical approach to applying probability and statistics theory to the study of complicated situations, the Bayesian network is largely a tool for evaluating complex data and reasoning about unknown aspects (Canonne et al. 2020). In recent years, it has been frequently employed in the area of artificial intelligence. Bayesian networks are largely separated into static and dynamic variants. A static Bayesian network typically employs a directed acyclic graph to illustrate the causal link between several random variables. It is basically composed of network structure and parameters.

From the standpoint of network structure, in the directed acyclic graph of a Bayesian network, nodes are utilized to represent each random variable in the Bayesian model, and the directed edges reflect the causal link between each variable. The network parameters are essentially specified by the conditional probability table, and each variable in the Bayesian network has a probability distribution. It may be assumed that the parent node of a node N is represented by h(N), and the root node conforms to the edge distribution, but the relationship between the root node and its parent node conforms to the conditional probability distribution H(N|h(N)).

The directed acyclic graph employed in Bayesian networks may not only depict the dependency between multiple random variables but also reflect the joint probability distribution rule between diverse variables. If the random variables in the Bayesian network are N1, N2,...Nm, the joint probability distributionbetween these variables may be determined as follows [16]:

$$H(N_1, N_2, \cdots, N_m) = \prod_{i=1}^{m} H(N_i|h(N_i)) \tag{6}$$

The dynamic Bayesian network (DBN) largely links the static Bayesian network with time; that is, it extends the static Bayesian network in time. A dynamic Bayesian network is a random network modelthat can analyze real-time data based on probability distributions. By adding time components to the static Bayesian network, not only the random variable data in the network may be updated in real time, but also the network structure and parameters are continually changing. Therefore, a dynamic Bayesian networkmay be better employed to cope with real-time data and hierarchical knowledge expression.

If a dynamic Bayesian network is represented as (r0, rz), where r0 represents a simple static Bayesian network, assuming that its starting conditional probability distribution is H(X0), and rz depicts a Bayesian network encompassing neighboring time periods, and given the conditional distribution of each random variable in the adjacent time periods, the calculation formula is as follows (Gao, Yang, and Guo 2019):

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$$H(X_t|X_{t-1}) = \prod_{i=1}^{M} H(X_t^i|h(X_t^i)) \quad (7)$$

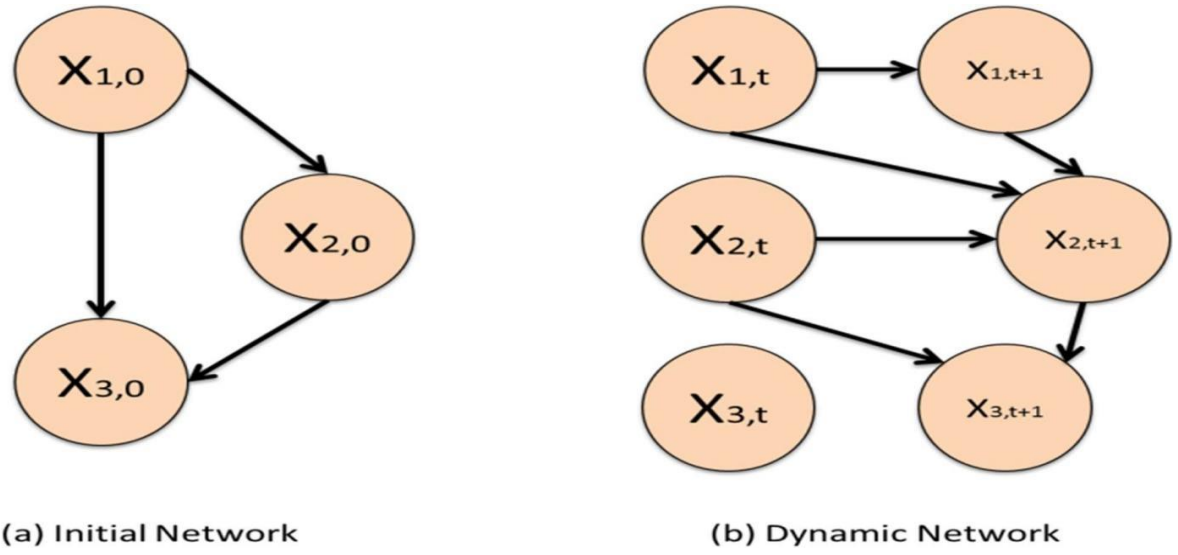
Where Xit represents the node i at a specific time t, and the parent node of Xit is represented by h (Xit) . The parameters of all nodes in the initial time period of the dynamic Bayesian network may be disregarded, and the conditional probability and its parent node can be in the same time period is H(Xit|h(Xit)).Node Xit and its parent node might be in the same time period or in the prior time period of node Xi. Generally, the directed edges in dynamic Bayesian networks fluctuate with time, in which the directed edges in the same time period mostly play a transitory role, while the directed edges in the neighboring time periods mainly play a time-varying role (Canonne et al. 2020; Scanagatta et al. 2018).

As illustrated in Figure 4, it illustrates the development process of the dynamic Bayesian network model.

A Bayesian network may be used to deal with and evaluate ambiguous and complicated issues. For the issue of random occurrences with probabilistic features, we may utilize graph theory and probability theory in Bayesian networks to study the causal link between random events. For example, the structure diagram in Bayesian networks may easily show the interaction connection between random variables. For random events with uncertain characteristics, a Bayesian network can not only make full use of the existing prior knowledge and massive data to effectively avoid the influence of various subjective factors on the network construction process, but can also use expert knowledge and combine the existing real data to construct the network. In addition, for the processing of incomplete data sets, Bayesian networks may handle the difficulties of incomplete data sets by means of structure learning and parameter learning.

Figure 4

The construction phase of the dynamic Bayesian network model



As an excellent reasoning tool of expert system for uncertain random occurrences, Bayesian network can investigate the inherent laws buried in huge data, and has been widely employed in artificial intelligence and data mining (Gao, Yang, and Guo 2019; Scutari 2020). In the process of establishing the relationship network of random occurrences, we need to examine and process the data using Bayesian network learning approach. Among them, structural learning is largely to create the structural connection of the network model and identify the conditional probability parameters of the network model. Parameter learning is to study the distribution law of conditional probability parameters on the basis of the current network topology.

In developing the structure of Bayesian network, it may be formed by expert knowledge or on the basis of data analysis and processing. Because the network structure constructed according to expert knowledge is greatly affected by human subjective factors and may lead to inaccurate structure, the Bayesian network structure is usually constructed by referring to existing expert knowledge and adopting data analysis and processing methods to ensure the effectiveness of the

network structure. Through the structure learning of Bayesian network, data can be efficiently processed, and the network structure between random variables can be constructed, so as to investigate the qualitative and quantitative links between diverse variables. Generally, the structure learning of Bayesian networks may adopt the learning approach based on data analysis or the learning method based on score search.

Construction of Human Resources Performance Appraisal Model

Using the aforementioned dynamic Bayesian network, we may develop a performance assessment model for corporate workers and dynamically evaluate and control their performance. Performance appraisal theories require selecting appraisal indicators before building the appraisal system and using dynamic Bayesian network theory to build the appraisal model. Due to the large number of employees and the complexity of work, Bayesian network theory can be used with actual relevant data to objectively assess employee performance at different levels and scientifically evaluate and predict employee performance.

Enterprise HR performance appraisals focus on employee performance, accountability, ability, customer feedback, etc. Thus, the balanced scorecard approach may be utilized to create an employee performance rating model with four dimensions: financial, customer, attendance, and quality. Each dimension is separated into multiple assessment indications.

Figure 5

Balanced scorecard personnel performance evaluation model schematic.

Figure 5 shows the balanced scorecard personnel performance assessment model design.

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The people performance evaluation approach calculates the model's output:

$$R = \sum_{i=1}^{m} y_i w_i$$

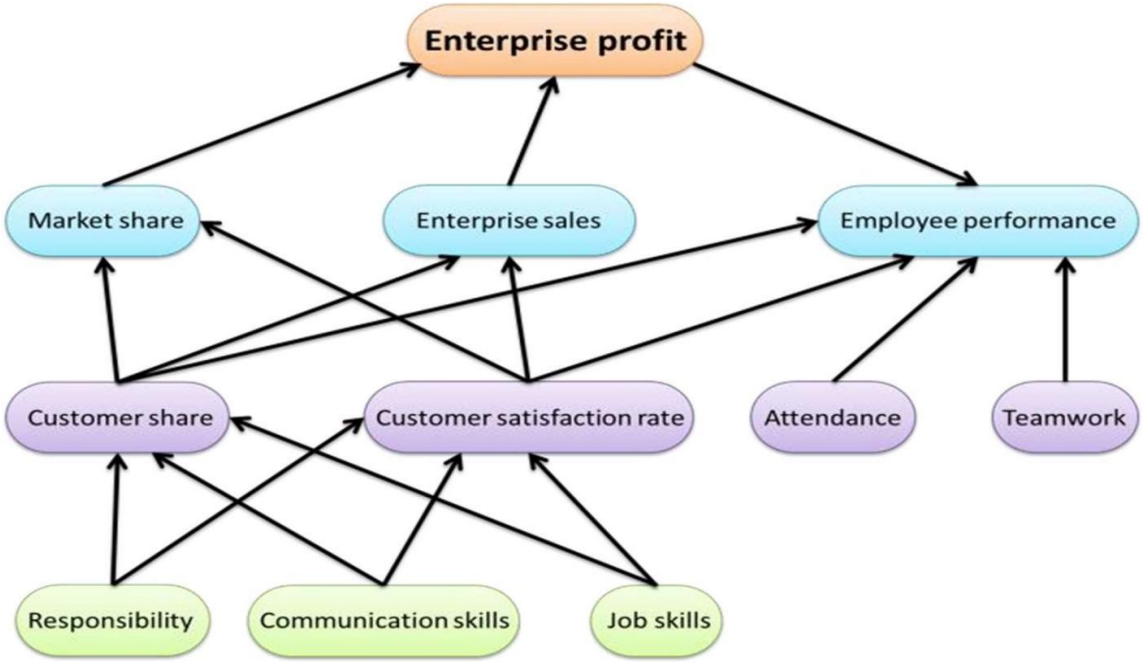
$$y_i = \sum_{j=1}^{n} \lambda(y_{ij}) w_{ij}$$

$$\sum_{i=1}^{m} w_i = 1$$

$$\sum_{j=1}^{n} w_{ij} = 1$$

Figure 6

Influencing variables' causal relationships.



(8)

(9)

(10)

(11)

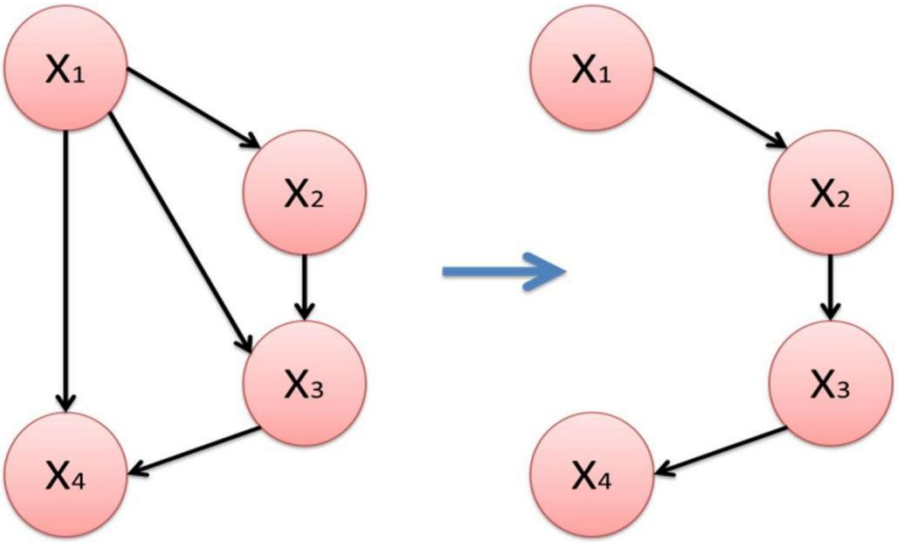
Where R ε [0, 1] is the output value of the people performance assessment model, m is the number of dimensions, yi is the i-th dimension, and wi is its weight. Yij is the i-th dimension's j-th indicator. wij is the i-th dimension's j-th indicator weight. Normalize Yij's index value using Formula (10) shows the weight total of each dimension is 1, whereas formula (11) shows the weight sum of all indicators under each dimension.

The performance evaluation methodology focuses on independent employee performance indicators. Bayesian network building allows us to create a causal association diagram between employee performance elements. Figure 6 depicts

causal relationships between affecting variables.

Figure 7

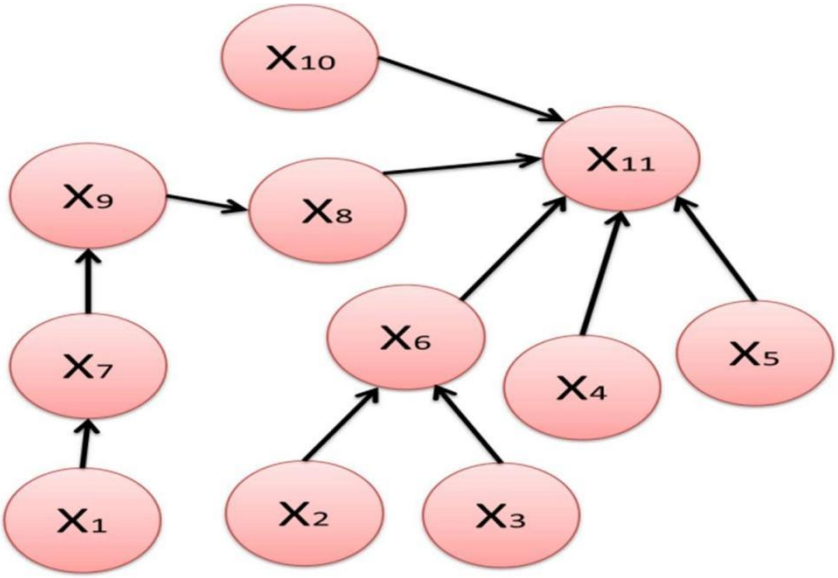
Optimizing factor relationship diagrams between nodes.



Since employee performance affecting elements may have repeated causal links, the causal relationship diagram may be improved (Cengiz, Dunder, and Senel 2018). The optimization procedure retains the indirect route between two nodes in the network relationship diagram and deletes the direct path. Figure 7 describes improving the factor relationship diagram between each node.

Figure 8

Bayesian network-based employee performance assessment.



Thus, we can reprocess the employee performance influencing factor connection graph using the optimization technique of the node relationship graph to generate the Bayesian network-based employee performance assessment model

illustrated in Figure 8.

EXPERIMENT AND ANALYSIS

EXPERIMENTAL DESIGN AND DATA PROCESSING METHOD

This research uses the balanced scorecard approach to build an employee performance evaluation system for a company to evaluate the Bayesian network-based human resource performance appraisal model. The employee performance assessment system uses the full viewpoint evaluation approach. Workers evaluate each other, effective leaders evaluate workers, and the personnel management department evaluates employees. Assume the assessment score range is 1–5, with 5 being the highest and 1 the lowest. Employee assessment results may be produced by weighing departmental or personnel evaluation ratings.

The assessment result of the i-th employee for the j-th employee is Sij = (Sij1, Sij2,..., Siijn). The ratio of the i-th employee's score to the j-th employee's performance is ij. The formula for calculating the j- th employee's performance assessment value is:

$$g_{jk} = \sum_{i=1}^{M} s_{ijk} w_k \tag{12}$$

$$g_j = \sum_{i=1}^{M} \left(\sum_{k=1}^{N} s_{ijk} w_k W_k \right) \omega_{ij} \tag{13}$$

The j-th employee's k-th index assessment score is gjk. M is the number of employees engaging in performance assessment, N is the number of indicators, wk is the weight of the N-th indicator in the appraisal system under the appropriate dimension, and denotes the evaluation system's dimension carrying the N-th indicator's weight.

Table 1

Balanced scorecard-based employee performance evaluation.

Dimension	Dimension Weight	Key indicators	Indicatorweight
Financial aspect	0.35	Enterprise profit (F1)	0.53
		Enterprise production value (F2)	0.35
		Corporate debt (F3)	0.12
Personal work	0.35	Job skills (P1)	0.55
		Work responsibility (P2)	0.27
		Dedication (P3)	0.18
Enterprise management	0.15	Work attendance (E1)	0.78
		Violation of discipline (E2)	0.22
Customer service	0.15	Communication skills (C1)	0.48
		Customer satisfaction (C2)	0.35
		Customer share (C3)	0.17

Table 2

Employee performance assessment outcomes.

Employee ID	F1	F2	F3	P1	P2	P3	E1	E2	C1	C2	C3	Employee performance
1	4.3	3.5	4.1	4.5	3.8	3.7	4.4	3.9	4.3	3.5	4.6	4.13
5	3.8	4.1	3.7	4.2	3.5	3.2	4.1	3.3	3.9	3.8	4.1	3.78

10	3.9	4.3	3.6	3.7	3.8	3.6	4.2	3.7	4.2	3.2	4.3	3.86
15	4.1	3.7	3.9	3.8	3.7	3.3	4.1	3.6	4.1	3.7	4.2	3.83
20	4.2	3.6	4.2	3.9	3.4	3.8	4.3	3.5	4.1	3.8	4.1	3.95

Results and Analysis

Table 1 shows the balanced scorecard-based employee performance evaluation methodology. Its four key dimensions—finance, personal work, corporate management, and customer service—impact employee performance. Each dimension has employee performance indicators. The performancerating method weights various aspects and indicators according to their relevance.

The aforementioned assessment methodology may be used to score all workers' performance appraisals. Table 2 shows employee performance assessment findings.

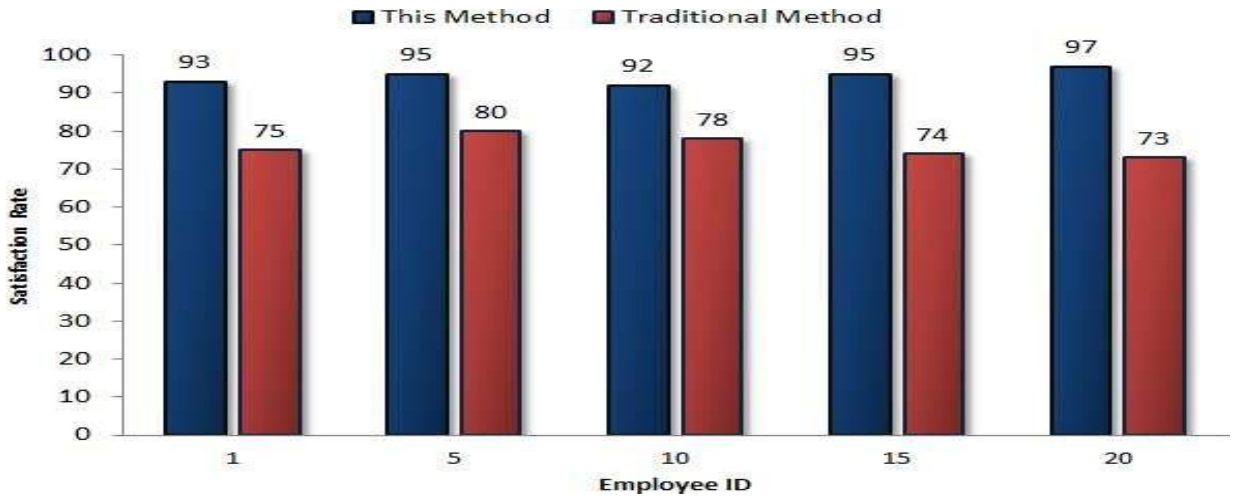
Figure 9

Performance evaluation results comparison.

This research compares its performance evaluation methodology to the old way. Figure 9 compares employee performance evaluation methodologies.

Figure 10

Employee performance evaluation satisfaction rates by technique.



The experiment's satisfaction study of performance assessment results from various methodologies demonstrated the feasibility and superiority of this paper's method. Figure 10 compares satisfaction following performance assessment by

various techniques. The figure shows that the performance assessment approach provided in this study yields more satisfaction than the old way.

This article assumes basic statistical analysis and human resource management skills. The article provides a basic overview of the performance assessment process and how sophisticated statistical analysis might enhance it. It does not specify the dataset utilized in the research. The suggested performance assessment system uses Bayesian network analysis and the balanced scorecard. The study's dataset is not disclosed; however, the trials show that the suggested strategy improves performance rating models' impartiality and flexibility. This study highlights the importance of employing sophisticated statistical analytic methods and new technology to enhance the objectivity and flexibility of standard performance rating models in human resource management. The document offers practical advice on enhancing performance evaluation in contemporary businesses.

Conclusion and Suggestions

The quick growth of new technologies like economic society, computers, and big data makes classic human resource performance management concerns unsuitable for current firm development. This report proposes a Bayesian network-based human resource performance assessment model using large data sets and new technologies. This paper explained the human resources appraisal indicators and their impact on employee performance and analyzed the common application methods for building the performance appraisal system. The suggested performance assessment system uses Bayesian network analysis and the balanced scorecard. The study's trials show that the suggested strategy improves performance rating models' objectivity and flexibility. The study then explained Bayesian network theory and its benefits in handling random issues and developed a Bayesian network-based human resource performance assessment model. This study built a performance assessment system using the balanced scorecard approach and tested it using an example. The trials show that the suggested strategy can find and fix data patterns. The approach may detect assessment biases and provide ways to improve the process. This study focuses on employing sophisticated statistical analysis and modern technology to enhance performance assessment in human resource management.

The suggested technique enhances performance rating model objectivity and flexibility. Advanced statistical analysis helps us discover evaluation biases and improve current corporate human resource management tactics. The balanced scorecard system also evaluates employee performance using financial performance, customer satisfaction, and employee development.

The suggested approach has significant limitations. Bayesian network analysis may be difficult to execute without specialized understanding. Advanced statistical analysis methods demand time and money, which may not be possible for many firms.

The suggested technique advances HR management. Advanced statistical analysis and new technology may help us understand the performance evaluation process and how to enhance it for contemporary businesses. We urge more study and development in this field since the suggested method's advantages exceed its shortcomings.

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