

# International Journal of Knowledge Processing Studies (KPS)



Homepage: <http://kps.artahub.ir/>



## ORIGINAL RESEARCH ARTICLE

### Identification of Players in the Database of Public and Private Banks with a Meta-Heuristic Algorithm

Ali Zare Abarghouei<sup>1</sup>, Mohammad Reza Davi<sup>2,\*</sup>, Zahra Dashtlaali<sup>3</sup>

<sup>1</sup>Ph.D. Candidate, Adaptive Management, Department of Management, Dehaghan Branch, Islamic Azad University, Dehaghan, Isfahan, Iran. [zareabarghouei@gmail.com](mailto:zareabarghouei@gmail.com)

<sup>2</sup>Associate Professor, Department of Management, Dehaghan Branch, Islamic Azad University, Dehaghan, Iran. (Corresponding Author) [dr.dalvi2016@gmail.com](mailto:dr.dalvi2016@gmail.com), 0000-0003-1262-8818

<sup>3</sup>Assistant Professor, Department of Management, Dehaghan Branch, Islamic Azad University, Dehaghan, Iran. [zahra.dashtlaali@gmail.com](mailto:zahra.dashtlaali@gmail.com)

#### ARTICLE INFO

##### Article History:

Received: 2024-04-12  
Revised: 2024-05-14  
Accepted: 2024-06-20  
Published: 2024-09-01

##### Keywords:

A-Player, Job Classification, State Bank, Private Bank, Metaheuristic Algorithm.

Number of Reference: 41

Number of Figures: 2

Number of Tables: 5

DOI: 10.22034/kps.2024.452140.1181



#### ABSTRACT

The research aims to identify players in the database of public and private banks using a meta-heuristic algorithm. This issue pertains to enhancing the human resources management system to ensure consistent stability in the bank's operations. In this database analysis process, Poisson distribution and artificial intelligence are utilized to analyze data with an exponential distribution. For this purpose, the VIS, CNSGA-II, NSGA-II, MISA, NNIA, and NRGGA algorithms were implemented using MATLAB software. The VIS algorithm showed the best performance in most criteria. Algorithms CNSGA-II and MISA are both ranked second and exhibit similar performances. NSGA-II algorithm is ranked second. The NNIA algorithm performs the best, while the NRGGA algorithm performs the worst. These analyses are conducted to assess the performance of algorithms based on various criteria. The results obtained from these analyses show that the VIS algorithm generally demonstrates the best performance. This means that VIS is known as an identification of players in the databases of public and private banks. In addition to the Variable in Neighborhood Search (VIS) algorithm, other algorithms like CNSGA-II and MISA are also closely ranked and share the second position in various criteria. These algorithms have similar functions and can make comparable enhancements in identifying players in the databases of public and private banks. ©authors

► **Citation:** Zare Abarghouei, A., Dalvi, M., & Dashtlaali, Z. (2024). Identification of Players in the Database of Public and Private Banks with a Meta-Heuristic Algorithm. *International Journal of Knowledge Processing Studies (KPS)*, 4(3): 112-127. Doi: 10.22034/kps.2024.452140.1181

## 1. Introduction

Database and data play a crucial role in human resource management and contribute significantly to various activities associated with human resource management (Ma & Chen, 2023; Papineni et al., 2021). These systems are among the fundamental tools that organizations use to recruit, select, promote, and manage their employees (Zheng et al., 2023). Information and databases help organizations to manage and organize data about their employees in a structured and systematic way (Wei, 2022). This information includes personal details, educational background, work experience, skills, and performance records of employees. By having this information stored in a database, managers can make better decisions in various management areas such as selection and hiring, assignment of duties, and professional development. Databases and data enable organizations to obtain and analyze detailed information and statistics about their employees' performance (Stone et al., 2015). This information can be used to evaluate performance, identify training needs, and plan for employee development (Ryan & Herleman, 2016). These analyses help managers understand more precisely how they can best utilize their employees and enhance the organization's performance (Chalutz-Ben Gal, 2023).

Also, the information and database allow organizations to enhance their management processes and progress towards optimizing human resources (Sela et al., 2018). With access to accurate and timely information, managers can improve processes such as recruiting, training and development, performance management, and creating reward and incentive policies to guide the organization towards achieving its strategic goals (Russell & Bennett, 2015). In this way, utilizing databases and data as powerful tools in human resource management ensures the improvement of efficiency and effectiveness within organizations (Traicoff, 2019).

The role of the database in identifying the key human resources of the organization is very important. Databases are fundamental

tools for managing information about employees and human resources, enabling organizations to effectively manage their human resources and leverage them as key organizational assets (Perrin, 2015). Databases play a crucial role in storing and managing personnel information within an organization. This information can include personal details, educational records, work experience, skills and qualifications, work performance, and other relevant information about each employee. By having this information in the database, the organization can efficiently utilize its human resources, identify its diverse needs, and implement suitable human resource strategies (Kansal & Jain, 2019).

Database analysis can be very useful in identifying key human resources within the organization. Organizational databases contain information about employees, their jobs, experiences, skills, achievements, and records. Using this information, it is possible to analyze the patterns and requirements necessary for successful performance in the organization (Ghosh & Sengupta, 2016). In this analysis, one can search for distinctive employee traits that signify superior performance or a specific ability within the organization (Dastyar et al., 2017). For example, one can recognize specific technical skills or more experience in a certain industry based on their achievements in past projects. This information can be effective in selecting and promoting key employees and developing human resources strategies (Pessach et al., 2020).

In addition, database analysis helps us identify behavioral patterns and the composition of work teams that lead to better performance (Aghabaghery et al., 2020). By examining information about employee interactions and collaborations, we can identify teams that produce the best results through high coordination and an appropriate distribution of skills. This helps the organization to make progress in the optimal use of human resources and improve the efficiency and performance of its work groups (Tanasescu & Bologa, 2022). Analyzing the organization's database

enables us to identify key human resources and implement suitable strategies for their management and development. This analysis can help improve the performance of the organization and the productivity of human resources, ultimately contributing to the growth and success of the organization (Bamber et al., 2017; Ye, 2022).

The metaheuristic algorithm is a computational approach used to identify critical human resources within the organization. This algorithm examines background data and behavioral patterns of employees using database analysis and aims to improve the performance of the organization (Zehir et al., 2020). The metaheuristic algorithm utilizes the organization's database to gather information about employees. This information includes employees' employment history, education, skills, achievements, and experiences. Then, using various methods such as data analysis, the algorithm searches for patterns and characteristics that represent essential human resources within the organization (Graczyk-Kucharska et al., 2023).

By analyzing these data and patterns, the algorithm can identify the potential of top employees and designate them as key human resources (Xue et al., 2019). This identification can be based on past performance on projects, experience in the relevant industry, specific technical skills, and leadership and collaboration abilities. With this information, the organization can adopt appropriate strategies to manage and develop these key human resources, providing them with proper promotion and career development based on it (Wiedmer, 2015). The metaheuristic algorithm identifies key human resources in the organization by analyzing databases and employee behavior patterns. This algorithm utilizes employee information to analyze employees' potential and abilities by examining data and patterns. This identification helps the organization adopt effective human resource strategies for the development and management of these key human resources, ultimately improving the performance and productivity of the organization. Therefore, this research aims to address the question of how to identify key

players in the databases of public and private banks using a metaheuristic algorithm.

## 2. Literature Review

Competence refers to the essential behaviors needed to attain the expected level of performance. Companies that value sustainable human resources management and quality (especially key human resources and A Players), and companies that feel responsible for taking care of employees and key positions as a top priority, should implement a systematic approach to data collection and analysis. The main methods of identifying key positions, competitive motivation, and recognizing key employees and A Players from internal and external sources involve communicating the importance of employee evaluation (Horowatwa, 2020).

Sustainable management and the quality of positions and A Players depend on the quality of talent management methods (Deloitte, 2019). Discovering talents can help localize the workforce and develop local development capabilities (Tate, Ramal, & Ferreira, 2023). For many managers, focusing on talent management is highly beneficial because it enables them to anticipate performance (Kaliannan, 2022). The most crucial role of a manager in an organization is to provide the human and material resources necessary to implement the established plan and to motivate employees to take on responsibility and propose initiatives. It is obvious that the way these roles are performed directly affects the efficiency and effectiveness of the organization and the level of customer satisfaction (D'Amato & Roome, 2019). In addition, the role of an employee's motivational profile (progress motivation and power motivation) in shaping his attitudes towards programs and its impact on organizational citizenship commitment and behaviors was studied (Malik & Singh, 2014). State banking is characterized by low productivity, inefficiency, and backwardness in the economic cycle, which can ultimately result in financial corruption. All work, including recruitment, selection, dismissal, and appointment of managers, is in

accordance with government laws. At the same time, they have the least creativity and group participation. (Angorani, 2017). Private banking, with greater flexibility compared to state banks, can enhance foreign credit expansion, cooperation, and interactions with international banks and bank brokers abroad. It can leverage the experiences of foreign banks and employ advanced banking techniques to effectively boost the country's investment across all economic sectors (Angorani, 2017). Therefore, the banking industry is deemed one of the most crucial sectors in any economy. Banks, alongside the stock market and insurance sector, serve as key pillars of financial markets by facilitating the flow of financial resources. Banking plays a crucial role in Iran's economy. This is because, in

the absence of a well-developed capital market, banks are primarily responsible for offering long-term financing. Also, in the process of financial market liberalization and integration with global markets, performance and efficiency are essential conditions (Nabipour Afrozi & Yazdanjo, 2022). In the meantime, banks and bank managers, due to having a wide range of customers and employees and a diverse range of operations, need to have an efficient and qualified workforce so that they can achieve the bank's efficiency.

Due to the significance of the research topic, studies have been conducted that differ in approach from the current study or have been carried out with specific objectives. Some examples are provided in the table below:

Table 1. Research background

Row	Research results	Research title	Scholar
1	Challenges of federal and state laws and court opinions based on legal standards and related to occupation and occupation classification.	Job analysis and job classification to address pay inequality in organizations through documentary research.	Strah et al. (2022)
2	The candidate matching system has demonstrated its feasibility and scalability in an important online recruitment site.	An embedding-based recommendation system for job-to-candidate matching at scale.	Zhao et al. (2021)
3	Interactional justice climate strengthens the direct effect of high-performance work systems on psychological and work attitudes, as well as the indirect effects of high-performance work systems on work attitudes.	High performance work systems and key employee attitudes.	Miao et al. (2020)
4	HR focuses on screening and interviewing only a small group of candidates, the best ones recommended by the system.	Examining job recommendation system and job classification.	Appadoo et al. (2020)
5	It automates the resume screening process, making it easy and time-efficient.	An integrated system for job class classification based on resume and job matching.	Lemba et al. (2020)
6	The effect of organizational policy variables, role ambiguity, job redesign, job demands on improving employee performance was not confirmed.	Key indicators of human resource management effective on improving employee performance.	Asgranjad Nouri and Mirmousavi (2020)
7	A model for vital jobs with 7 dimensions and another model with 3 dimensions for identifying key people was set.	Identifying critical and key job criteria for attracting and retaining talent in Iran's National Oil Tanker Company.	Mirzaei et al. (2019)
8	By using the method of structural equations and confirmatory factor analysis, some competencies were re-adjusted and the overall research model was finalized with 26 titles.	Identifying and validating the competencies of the key people of the tax affairs organization in the implementation of the comprehensive tax plan.	Arbabi et al. (2018)
9	8 jobs were identified as key people and the profile of each job was designed.	Compilation of the competence profile of strategic jobs in order to evaluate the strategic readiness of human capital.	Abdi et al. (2014)

Indeed, the lack of talented employees to fill key positions in the event of gaps remains an issue. Therefore, bank strategies are necessary to develop employees and create a wider pool of future internal talent base, ideally utilizing inclusive talent development (Asplund, 2020). Today's society expects the banking system to attract deposits, allocate them to useful economic activities, identify

key employees and A-players, update human resources, and enhance labor productivity.

### 3. Method

This research consists of 5 stages: understanding the field under investigation, defining the research problem, presenting the research model, designing the structure of the solution algorithms, and generating data for testing while adjusting the parameters of

the model and algorithms. First, the scope of the investigated problem was identified. Then, the parameters for identifying players were checked in the databases of public and private banks. In this research, to examine and study the theoretical foundations and existing models, I reviewed library studies, articles in international publications such as Elsevier and Springer, related books, dissertations, and databases. Internet was used. The identification of players in public and private banks is assumed to be influenced by the database process. In this research, the importance of these components has been determined based on their weighting according to the efficiency of the information management system. The weighting of the players' components in the databases of public and private banks was conducted using the method of analyzing gray relations with distance fuzzy numbers. In the next step of the research, a multi-level mathematical model was designed, incorporating the components of players in the databases of public and private banks. This model was based on the weights determined in the previous step.

To solve it, a multi-objective meta-heuristic algorithm utilizing the Pareto archive was implemented. After determining the set of optimal answers, the resulting responses were reviewed, and the final answer was chosen to enhance the database's ability to identify key human resources. In order to investigate the performance of metaheuristic methods, it is necessary to conduct experiments.

To answer this question, it is necessary to use several appropriate evaluation methods so that a comprehensive result can be derived from their outcomes. In this section, it is necessary to first create standard problems, and then these algorithms begin to solve these problems. The conditions and parameters set for implementing these algorithms should be consistent across all of them to ensure fair competition under the same conditions. For this purpose, the VIS, CNSGA-II, NSGA-II, MISA, NNIA, and NRGGA algorithms were implemented using MATLAB software.

### Research Model

A database system was considered that utilized internal and external factors to maximize profitability and minimize costs. The following general assumptions are considered:

- 1) The database is used to optimize the model in human resource management.
- 2) The database follows an independent Poisson flow.
- 3) Each productivity of the human resource management system is directly proportional to the service times of only one database.
- 4) There is an upper bound on maximum profitability and productivity.

To model this situation, the following symbols are established:

- $M = \{1, 2, \dots, m\}$ : set of component nodes
- $N = \{1, 2, \dots, n\}$ : set of nodes representing key human resources for productivity.
- $D = (d_{ij})$ : The distance matrix represents the distance from component node  $i$  to the productivity node identifying key human resources  $j$
- $\Lambda$ : Overall productivity rate of the key human resource identification system
- $\lambda_i$ : The rate of effective measures from the database
- $\gamma_j$ : The rate of actions affecting productivity has increased.
- $\mu$ : The average rate of actions in the productivity of the key human resources identification system.
- $w_j = (\mu - \gamma_j)^{-1}$ : The waiting time for the action assigned to the facilitation node of  $j \in N$
- $\bar{w}$ : The upper limit of the allowed waiting time for actions taken to enhance productivity
- $v = 1/\bar{w}$ : Excess productivity capacity to guarantee  $w_j \leq \bar{w}$
- $p$ : Number of productivity that actually led to profitability;
- $\bar{p}$ : The maximum number of units that can be produced profitably;

This issue can be stated as follows: Consider the following assumptions:

A set of effective measures from the database denoted by  $\lambda_i$ , a set of average rates of measures in the identification of key human resource productivity  $\mu$ , a positive integer  $\bar{P}$ , and a positive number  $\bar{W}$ ; A productivity set identifies the optimal human resources required to minimize the average total number of actions leading to maximum productivity in  $\bar{P}$  and waiting time. Also, consider the condition that the average waiting time in each productive process leading to profit is not greater than  $\bar{W}$ .

If  $\nu$  is the speed of actions and

$$y_j = \begin{cases} 1 & \text{If a productivity is opened in node } j \\ 0 & \text{Otherwise} \end{cases}$$

$$x_{ij} = \begin{cases} 1 & \text{If action } i \text{ leads to productivity } j \\ 0 & \text{Otherwise} \end{cases}$$

Therefore, the cumulative action time of the components per time unit is equal to:

$$T = \sum_{i \in M} \sum_{j \in N} \lambda_i d_{ij} x_{ij} / \nu$$

Hence, each productivity behaves as an  $M/M/1$  queue, the average waiting time at productivity location  $j$  is equal to  $W_j = 1/(\mu - \gamma_j)$  where  $\gamma_j = \sum_{i \in M} \lambda_i x_{ij}$ . Therefore, the cumulative action time of the components per time unit is equal to:

$$V = \sum_{i \in M} \sum_{j \in N} \lambda_i x_{ij} W_j = \sum_{j \in N} \frac{\gamma_j}{\mu - \gamma_j}$$

According to Little's Law, as described in the previous sections,  $T$  represents the average number of actions being performed, while  $V$  represents the average number of pending actions.

One of the system evaluation criteria is the system's uptime percentage. To demonstrate this standard, a factor known as productivity or efficiency coefficient is utilized, and it is defined as follows:

$$\rho = \frac{\text{The average of all actions to receive the service per unit of time}}{\text{The total capacity of the system for productivity per unit of time}}$$

According to this definition, the larger the value of  $\rho$ , the greater the demand and the system must do more work and the queue will be longer. On the contrary, the smaller  $\rho$  is, the shorter the time, but on the other hand, less system facilities are used.

Now, to calculate the average efficiency coefficient of player identification in our model, we need to first determine the total efficiency coefficient of the facilities and then divide it by the number of profitable player identification management systems in the database.

$$\frac{\sum_{i \in M} \sum_{j \in N} \lambda_i x_{ij}}{p\mu}$$

Or in other words:

$$\frac{\sum_{i \in M} \sum_{j \in N} \lambda_i x_{ij}}{\sum_{j \in N} \mu}$$

To ensure that actions move to the nearest point of profitable productivity, we need to:

$$\sum d_{ik} x_{ik} \leq (d_{ij} - \Delta) y_j + \Delta, \quad \forall i \in M, j \in N,$$

Where  $\Delta$  is a large positive number (like  $\Delta = \max\{d_{ij} : i \in M, j \in N\}$ ). When

$y_j = 0$ , because  $\Delta$  is large, this constraint becomes ineffective. When  $y_j = 1$ , action  $i$  cannot be assigned to a productivity that is further away from  $j$ , otherwise, this constraint is violated.

Therefore, the following mathematical programming formulation is obtained:

$$(1) \min \sum_{i \in M} \sum_{j \in N} \frac{\lambda_i d_{ij} x_{ij}}{\nu}$$

$$(2) \min \sum_{i \in M} \sum_{j \in N} \frac{\lambda_i x_{ij}}{\mu - \sum_{k \in M} \lambda_k x_{kj}}$$

$$\begin{aligned}
 (3) \quad & \max \frac{\sum_{i \in M} \sum_{j \in N} \lambda_i x_{ij}}{\sum_{j \in N} \mu} \\
 (4) \quad & \text{subject to} \quad \sum y_j \leq \bar{p}, \\
 (5) \quad & \sum_{j \in N} x_{ij} = 1, \quad \forall i \in M, \\
 (6) \quad & x_{ij} \leq y_j, \quad \forall i \in M, j \in N, \\
 (7) \quad & \sum_{k \in N} d_{ik} x_{ik} \leq (d_{ij} - \Delta) y_j + \Delta, \quad \forall i \in M, j \in N, \\
 (8) \quad & \sum_{i \in M} \lambda_i x_{ij} \leq \mu - v, \quad \forall i \in M, j \in N \\
 & y_j \in \{0,1\}, \quad x_{ij} \in \{0,1\} \quad \forall i \in M, j \in N
 \end{aligned}$$

Goal (1) aims to minimize the average number of actions in progress, goal (2) aims to minimize the average number of pending actions, and goal (3) aims to maximize the total functionality of the player identification system in the databases of public and private banks. It is in the unit of time. These goals align with the stated constraints, with constraint (4) specifying the maximum level of productivity that can be profitable. Constraints (5) and (6) ensure that each action demand is efficient and results in profitable efficiency. Constraint (7) also ensures that this action is carried out with the highest level of efficiency. At the end of constraint (8), it ensures that the average waiting time at each productivity level does not exceed  $\bar{W}$ .

#### 4. Findings

To perform the NSGA-II algorithm, the population size was set to 100 and the probability of crossover and mutation was set to 0.5 and 0.4. To generate the initial population, he randomly created a string of zeros and ones of length N. If this string met the criteria for the maximum number of facilities and the waiting time of customers, then this solution was considered acceptable. If not, this solution was discarded, and a new solution was generated. The value  $\bar{W}$  is considered equal to 0.5 for all problems. Considering that this algorithm is derived from the NSGA-II algorithm, all of its parameters are also in accordance with that algorithm. The only difference lies in the selection mechanism. As described in the previous section, to execute this mechanism, we need to calculate the deviation of the solutions from the constraints. For problems with limits in the form of routine mathematical equations, calculating these deviations is not a difficult task. However, when we encounter unfair restrictions, we must consider an alternative method. To calculate the deviation from the first limit, i.e., the maximum number allowed for facilitation, the following formula was used:

$$Violation_1 = \frac{\sum_{j \in N} y_j - \bar{P}}{N - \bar{P}}$$

The following formula was used to calculate the second limit, i.e. compliance with the maximum waiting time of customers in the queue:

$$Violation_2 = \frac{\sum_{j \in N} \left( \mu - \sum_{i \in M} \lambda_i x_{ij} - \frac{1}{\bar{W}} \right)}{\mu - \sum_{i \in M} \lambda_i - \frac{1}{\bar{W}}}$$

In the case of the above limitation,  $j \in N$  means the facilities that have been created and violated the second limitation. The desired components in the field of key human resources are specified in the table:

**Table 2.** Strategies for identifying key human resources in private and public banks

Concept	Category	Coding key human resources
Development strategy	Internal organization	Discovering the active capacities of key employees
		Talent search mechanism from human resources
		Strategic management of talent flow
		Controlling negative emotions among employees

Concept	Category	Coding key human resources
		Recruiting and maintaining skilled and efficient people
		Creating a source of qualified employees
		Strengthening internal forces
		Strengthening the identity of key forces
		Supporting creativity and organizational dynamics
		Developing the professional qualifications of Group B employees
		Improving training skills of human resources
		Development of social networks of human resources
		Strengthening the motivational potential of jobs
		Matching the identified talent and the existing position
	External organization	Identify critical operational situations
		Creating incentives to attract capable people outside the organization
		Trying to attract technological human capital
		Organizing competitive events at the national-transnational level
		Easing the rules of recruitment of key forces
		Creating performance evaluation models of key forces
Supportive strategy	Care management	Human resource demand management
		Pathology of job evaluation model
		Attention to the needs of key employees
		Strengthening the culture of meritocracy
		Retention of key employees
	Review	Revision of the current job classification system
		Motivating active human resources
		Strengthening succession policies
		Increasing investment in human resources development
		Reviewing the process of attracting and promoting key employees
		Revision of bank rules and regulations
		Reengineering the human resources performance evaluation system
Creation strategy	Key business policy	Sustainable policies for embedding talent knowledge
		Merit-based pay to employees in key jobs
		Creating learning opportunities from group A
		Development of a job classification model based on group A activity
		The policy of stability of key forces in sensitive jobs
	Organizational memory	Modeling the experiences of retired key employees
		Strengthening the middle circles of key businesses
		Record important events and key employee performances
		Educating key jobs
		Development of scenarios related to the future of key jobs

The results obtained were in accordance with the following parameters: a population size of 100, secondary memory size of 100, and  $5 \times 5 \times 5$  matrix as an adaptive network. The intersection and jump operators used are similar to those in previous algorithms. We considered eight different criteria to compare and analyze algorithms. These eight criteria

are: generational distance, degree of balance in simultaneously achieving goals, area under the regression line, number of final non-dominant solutions, spacing, expansion, convergence speed, and the area covered by two sets. In this section, the measurement of these criteria was discussed for all algorithms.

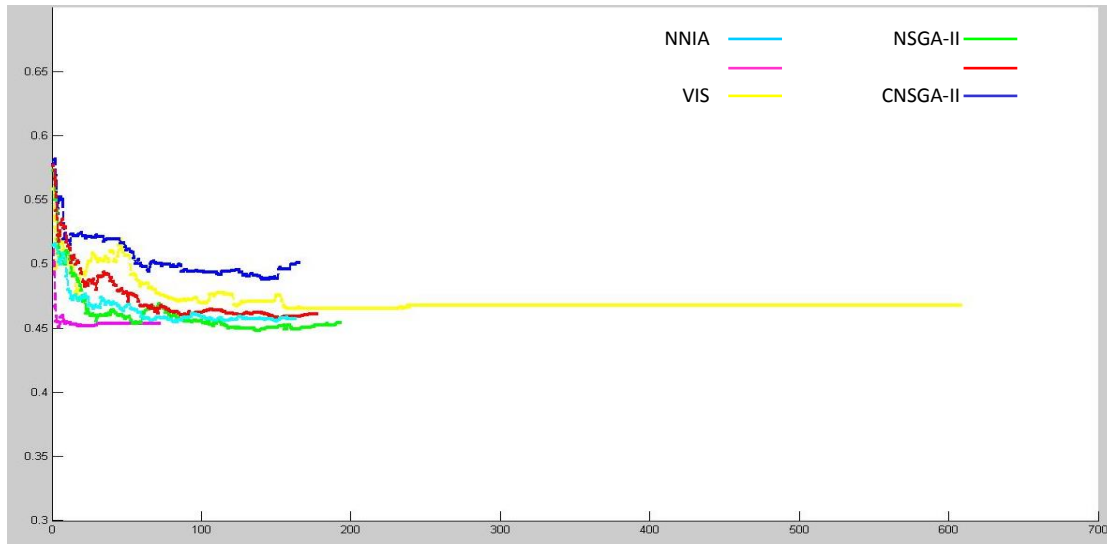


Figure 1. Algorithm convergence diagram based on MID index

According to the obtained results, the algorithms can be compared with each other. As shown in the third to ninth lines of Figure 1, the software has compared and grouped the algorithms in order. Levels that share a letter mean that they are not significantly different, and conversely, if they do not share a letter, it means that they are significantly different. The grouping table shows that group A includes the VIS algorithm. Also, group B includes CNSGA-

II and NSGA-II algorithms. While group C includes NSGA-II, MISA and NNIA algorithms. And finally, the NRGGA algorithm belongs to group D. As a result, it can be said that at the 95% confidence level, the performance of the algorithms from the point of view of the number of non-defeated solutions is shown in Table 3. Of course, schematically, this comparison is shown more prominently in Figure 2.

Table 3. Algorithm grouping based on the criterion of the number of non-defeated solutions

Algorithm	Rank Algorithm
VIS	1
CNSGA-II	2
NSGA-II	3
MISA NNIA	4
NRGA	5

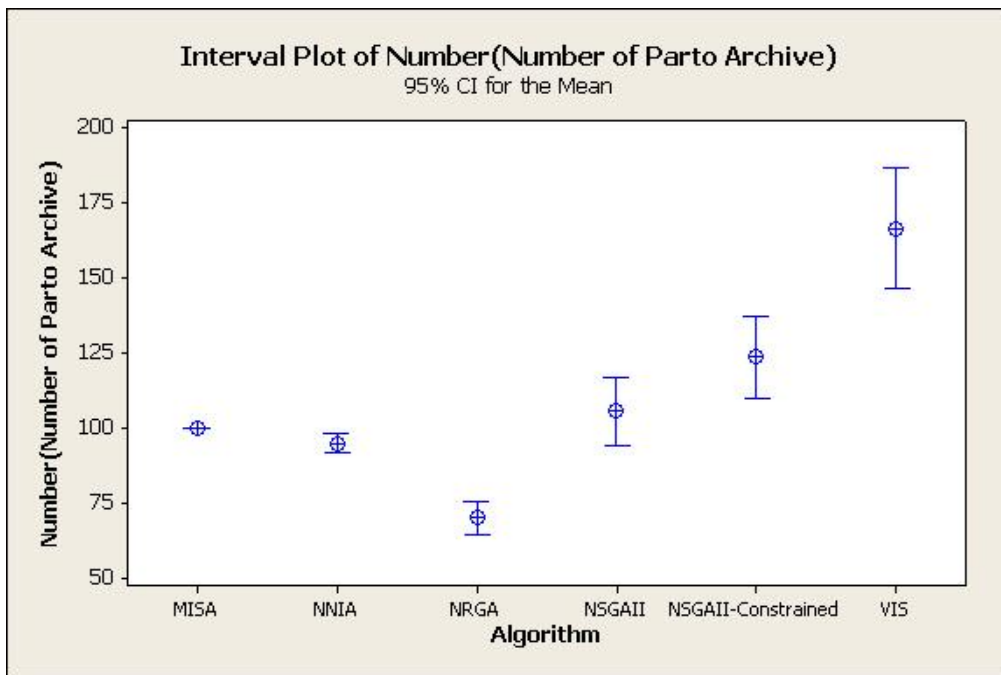


Figure 2. The result obtained from the analysis of variance for the number of non-dominant answers

Similarly, the same analysis was done for all criteria, and we have also calculated these criteria for all states of hard problems, simple problems, small problems, and big problems, and we only mention the graphs of these analyzes in Appendix B. The final results of these analyzes can be seen in Table 4. In this table, the algorithms are valued based on each criterion, which indicates their rank among other algorithms. Regarding the "generational gap" criterion, apart from the case of simple problems, in all

cases, the algorithms have not shown much difference; In simple terms, the first rank is given to NSGA-II, the second rank to CNSGA-II, the third rank to VIS and NNIA, the fourth rank to MISA and finally the last rank to NRGGA. Regarding the two criteria "degree of balance in simultaneously reaching the goals" and "area under the regression line", the algorithms have not shown significant differences in different modes, and in terms of these two criteria, the algorithms have no significant difference from each other.

Table 4. Comparison of algorithms in terms of different criteria and in different modes

The number of non-defeated answers					Area under the regression line					The degree of balance in achieving goals at the same time					Generation gap					
Big	Small	Hard	Simple	Total	Big	Small	Hard	Simple	Total	Big	Small	Hard	Simple	Total	Big	Small	Hard	Simple	Total	
3	2	2	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	NSGAI
2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	CNSGAI I
5	4	3	5	5	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	NRGA
4	3	2	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	NNIA
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	VIS
4	2	2	4	4	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	MISA

The area covered by two sets	Convergence speed	Expansion	Spacing	
------------------------------	-------------------	-----------	---------	--

Big	Small	Hard	Simple	Total	Big	Small	Hard	Simple	Total	Big	Small	Hard	Simple	Total	Big	Small	Hard	Simple	Total	
3	3	3	3	4	2	3	3	3	3	1	3	1	4	3	1	3	2	2	1	NSGAII
2	2	2	2	2	2	3	3	3	3	1	2	1	3	2	1	2	1	2	1	CNSGAII
4	5	4	4	6	2	3	3	4	3	1	2	1	2	2	3	4	3	4	2	NRGA
3	4	3	3	5	2	3	3	4	3	1	2	1	4	2	2	2	1	2	1	NNIA
1	1	1	1	1	2	2	2	2	2	1	2	1	3	2	1	1	1	1	1	VIS
2	3	2	3	3	1	1	1	1	1	1	1	1	1	1	2	2	1	3	1	MISA

In terms of the "number of non-defeated solutions" criterion, the VIS algorithm consistently achieved the highest rank in all cases, while the NRGA algorithm consistently ranked the lowest. With very few exceptions, in all scenarios, CNSGA-II is assigned the second rank, NSGA-II the third rank, and jointly NNIA and MISA the fourth rank. Regarding the "spacing" criterion, the only definite conclusion that can be drawn is that the VIS algorithm ranks first, while the NRGA algorithm ranks last. It is not possible to draw a definitive conclusion about the expansion criterion. Based on our analysis, the MISA algorithm is ranked first, while the NSGA-II algorithm is ranked last. MISA has performed well in terms of convergence speed and has consistently ranked first in all cases. With a slight approximation, the VIS algorithm ranks second. Regarding the "area covered by two sets" criterion, which is one of the most important criteria, with a slight approximation in all cases, the rankings are

as follows: VIS ranks first, CNSGA-II ranks second, MISA ranks third, NSGA-II ranks fourth, NNIA ranks fifth, and finally, the NRGA algorithm. In this way, the performance of algorithms is generally determined based on various criteria. It is up to the decision maker to determine which criteria are more important to them and to choose an algorithm that has performed well based on those criteria. If all the criteria are equally important for the decision maker, the average of all the criteria can be considered for the algorithms. The rank of each algorithm can then be determined based on all the criteria. The results are presented in Table 5, where it is evident that the VIS algorithm outperformed the others. Algorithms CNSGA-II and MISA are both ranked second and have demonstrated nearly identical performances. NSGA-II algorithm is ranked second. The NNIA algorithm ranks next in terms of performance, while the NRGA algorithm is assigned the worst performance.

Table 5. Average Criteria of Algorithms and Ranking of Algorithms Based on it

Final rank	Algorithm rank according to average criteria					Average criteria					Algorithms
	Big	Small	Hard	Simple	Total	Big	Small	Hard	Simple	Total	
3.4	3	4	4	3	3	1.625	2.125	3.4	2.25	2.125	NSGAII
2.4	2	3	3	2	2	1.375	1.75	2.4	2	1.625	CNSGAII
5	5	5	5	5	5	2.25	2.625	5	3.25	2.625	NRGA
4	4	4	4	4	4	1.875	2.125	4	2.75	2.25	NNIA
1	1	1	1	1	1	1.125	1.25	1	1.625	1.25	VIS
2.4	3	2	2	3	2	1.625	1.5	2.4	2.25	1.625	MISA

5. Discussion

Compared to other studies, researchers such as Strah et al. (2022) have focused on job analysis and job classification to systematically define and categorize jobs, as well as address legal issues during the hiring process. Lamba et al. (2020) emphasize the importance of automatically selecting the

right candidate for a job profile to minimize additional efforts, time, and costs. Zhao et al. (2020) developed a system to offer HR professionals a sorted list of the most suitable candidates first. In Iran, Arbabi et al. (2018) examined the scientific literature related to the concept of competence and previous research documents. They extracted

50 competency titles for jobs. Additionally, Abdi et al. and Mirzaei et al. (2019) developed a model for critical jobs and another model for identifying key individuals. Asgranjad Nouri and Mirmusoi (2022) found that variables such as organizational commitment, organizational support, performance evaluation system, creativity and innovation, collaborative management, training and development programs, human resource empowerment, career path development, and career motivation have a positive effect on enhancing employee performance. Miao et al. (2020) found that high-performance work systems are positively associated with job satisfaction and emotional commitment, which aligns with the findings of this research. Therefore, it is suggested to recruit the most qualified individuals and empower them to take risks while providing continuous support. Creating an atmosphere of mutual understanding, especially during times when the cultural values of the organization differ. Also, creating an environment where employees can utilize all their skills to enhance their abilities. A proper definition of the potential and various talents required within the system should align with the organization's strategy and structure. This will accelerate the professional development and advancement of certain employees, enhance the efficiency of innovation opportunities, and ultimately, ensure the evaluation and monitoring of employees, particularly in terms of knowledge and skills, in both public and private banks.

## **6. Conclusion**

The identification of players within the databases of both public and private banks using a meta-heuristic algorithm produces multifaceted outcomes with significant implications for various sectors. By utilizing a meta-heuristic algorithm, a computational method specifically designed to efficiently solve optimization problems, the process of player identification becomes more nuanced and effective.

One of the key advantages of using a metaheuristic algorithm in this context is its ability to navigate complex and dynamic datasets inherent in banking databases. These algorithms excel in handling large volumes of data while adapting to changing conditions, making them well-suited for identifying patterns and anomalies associated with various players, whether they are individuals, organizations, or entities.

Moreover, the integration of a metaheuristic algorithm allows for the consideration of multiple criteria simultaneously, enhancing the accuracy and robustness of player identification. Unlike traditional methods that may focus on a single aspect of data analysis, metaheuristic algorithms can evaluate various parameters and constraints, leading to more comprehensive and insightful results.

Furthermore, the utilization of advanced algorithms facilitates continuous improvement and optimization of the player identification process over time. By iteratively refining the algorithm's parameters and strategies based on feedback and real-world performance, banks can enhance their ability to detect fraudulent activities, assess creditworthiness, and mitigate risks associated with various players in their databases.

Overall, the integration of metaheuristic algorithms in identifying players within the databases of public and private banks represents a significant advancement in data analytics and decision-making processes. It empowers banks to leverage the full potential of their data resources, ultimately leading to more informed decisions, improved operational efficiency, and enhanced security in the financial ecosystem.

To solve this multi-objective problem, several meta-heuristic multi-objective algorithms were considered to assess their effectiveness in addressing such problems and to evaluate the outcomes they produce under varying conditions. Three algorithms, NSGA-II, CNSGA-II, and NREGA from the field of genetic algorithms, and MISA, VIS, and NNIA algorithms from the field of artificial intelligence, were selected for this study. For this purpose, sample problems

with varying structures were created based on their level of difficulty, complexity, and size. These problems were then solved using the algorithms mentioned.

To compare the results of these algorithms, performance criteria were needed to measure their efficiency. For this purpose, eight criteria were selected: generation gap, degree of balance in simultaneously achieving goals, area under the regression line, number of final non-dominated solutions, spacing, expansion, convergence speed, and the area covered by two sets.

The final results obtained from these analyses indicated that the VIS algorithm exhibited the best performance across most criteria. Algorithms CNSGA-II and MISA are both ranked second and exhibit similar performances. NSGA-II algorithm is ranked third. The NNIA algorithm performs better than the NRGGA algorithm, which exhibits the worst performance. These analyses are conducted to assess the performance of algorithms based on various criteria. The results obtained from these analyses show that the VIS algorithm generally demonstrates the best performance.

This means that VIS is recognized as a key algorithm for human resource identification. In addition to the Variable In Neighborhood Search (VIS) algorithm, other algorithms like CNSGA-II and MISA are also closely ranked and share the second position in various criteria. These algorithms have similar functions and can offer comparable enhancements in key HR identification management systems. The NNIA algorithm is next in terms of performance. This shows that NNIA can also make significant improvements in identifying key human resources. In the end, the NRGGA algorithm is known for having the worst performance in the criteria under investigation. This result can help avoid selecting the NRGGA algorithm in critical human resource identification systems and instead search for superior solutions to enhance the performance of these systems.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or

personal relationships that could have appeared to influence the work reported in this paper.

#### References

- Abdi, A., Akbarian, M., and Pourhsinlou, M. (1394). Compilation of competency profile of strategic jobs in order to evaluate the strategic readiness of human capital. *Human Resources Studies Quarterly*, 18, pp. 71-94. [in Persian]
- Aghabagheri, R., Golpayegani, A. H., & Esmaeili, L. (2020). A New Method for Organizational Process Model Discovery Through the Analysis of Workflows and Data Exchange Networks. *Social Network Analysis and Mining*, 10(1), 12. <https://doi.org/10.1007/s13278-020-0623-5>
- Angorani, M. (2017). *Analysis of the relationship between private and state banks*. Consultants Institute, Tehran. [in Persian]
- Appadoo, K., Soonnoo, M. B., & Mungloo-Dilmohamud, Z. (2020, December). Job recommendation system, machine learning, regression, classification, natural language processing. In *2020 IEEE Asia-Pacific Conference on Computer Science and Data Engineering (CSDE)* (pp. 1-6). IEEE. <https://doi.org/10.1109/CSDE50874.2020.9411584>
- Arbabi Manyá, A., Reza Zainabadi, H., Akbar Hasanpour, A. (2018). Identifying and validating the competencies of the key jobs of the tax affairs organization in the implementation of the comprehensive tax plan. *Tax Research Journal*, Number 42. [in Persian]
- Asgarnejad Nouri, B., & Mirmousavi, M. (2020). Meta-analysis of the key indicators of human resources management effective on improving the performance of employees. *Management, improvement and transformation studies*, 101, 126 to 160. [in Persian]
- Asplund, K. (2020). When profession trumps potential: The moderating role of professional identification in employees' reactions to talent management. *The International Journal of Human Resource Management*, 31(4), 539-561. <https://doi.org/10.1080/09585192.2019.1570307>

- Bamber, G. J., Bartram, T., & Stanton, P. (2017). HRM and workplace innovations: formulating research questions. *Personnel Review*, 46(7), 1216-1227. <https://doi.org/10.1108/PR-10-2017-0292>
- Chalutz-Ben Gal, H. (2023). Human Resources-Based Organizational Data Mining (HRODM): Themes, Trends, Focus, Future. In *Machine Learning for Data Science Handbook: Data Mining and Knowledge Discovery Handbook* (pp. 833-866). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-031-24628-9\\_36](https://doi.org/10.1007/978-3-031-24628-9_36)
- D'Amato, A., & Roome, N. (2009). Toward an integrated model of leadership for corporate responsibility and sustainable development: a process model of corporate responsibility beyond management innovation. *Corporate Governance: The international journal of business in society*. <https://doi.org/10.1108/14720700910984972>
- Dastyar, B., Kazemnejad, H., Sereshgi, A. A., & Jabalameli, M. A. (2017). Using Data Mining Techniques to Develop Knowledge Management in Organizations: A Review. *Journal of Engineering, Project, and Production Management*, 7(2), 80. <https://doi.org/10.32738/JEPPM.201707.004>
- Deloitte.2019. Managing Talent Flow. Available online: <https://www.google.com/>
- Ghosh, A., & Sengupta, T. (2016). Predictive analytics for human resources. edited by J. Fitz-Enz and II John Mattox, Hoboken, NJ, John Wiley and Sons, 2014, pp. 1–149.
- Graczyk-Kucharska, M., Olszewski, R., & Weber, G. W. (2023). The use of spatial data mining methods for modeling HR challenges of generation Z in greater Poland Region. *Central European Journal of Operations Research*, 31(1), 205-237. <https://doi.org/10.1007/s10100-022-00805-5>
- Horváthová, P., Velčovská, Š., Kauerová, L., & Larsen, F. R. (2019). Evaluation of Key Positions and Employees Management Level in Manufacturing Industry—The Czech Case. *Sustainability*, 12(1), 242. <https://doi.org/10.3390/su12010242>
- Kaliannan, M., Darmalinggam, D., Dorasamy, M., & Abraham, M. (2022). Inclusive talent development as a key talent management approach: A systematic literature review. *Human Resource Management Review*, 100926. <https://doi.org/10.1016/j.hrmr.2022.100926>
- Kansal, J., & Jain, N. (2019). Development of competency model and mapping of employee's competencies for organizational development: A new approach.
- Lamba, D., Goyal, S., Chitresh, V., & Gupta, N. (2020, May). An integrated system for occupational category classification based on resume and job matching. In *Proceedings of the International Conference on Innovative Computing & Communications (ICICC)*. <https://doi.org/10.2139/ssrn.3607282>
- Ma, H., & Chen, M. (2022, June). Application of Data Mining Technology (DMT) in Human Resources Assessment Management System. In *International Conference on Applications and Techniques in Cyber Intelligence* (pp. 155-162). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-031-29097-8\\_19](https://doi.org/10.1007/978-3-031-29097-8_19)
- Malik, A. R., & Singh, P. (2014). 'High potential' programs: Let's hear it for 'B'players. *Human Resource Management Review*, 24(4), 330-346. <https://doi.org/10.1016/j.hrmr.2014.06.001>
- Miao, R., Bozionelos, N., Zhou, W., & Newman, A. (2021). High-performance work systems and key employee attitudes: the roles of psychological capital and an interactional justice climate. *The International Journal of Human Resource Management*, 32(2), 443-477. <https://doi.org/10.1080/09585192.2019.1710722>
- Mirzaei, H., Qolipour, A., Seyedjavadin, R., & Hasanqolipour, T. (2019). *Identification of vital and key job criteria to attract and retain talents in the National Iranian Tanker Company*. 13th year public management research. Number 47. [in Persian]
- Nabi Pourafrouzi, M. & Yazdanjo, M. (2022). Analyzing the effectiveness and efficiency of financial intermediation as a financial participation strategy in the banking industry, <https://civilica.com/doc/>[in Persian]
- Papineni, S., Reddy, A.M., Yarlagaadda, S., et al. (2021). An extensive analytical

- approach on human resources using random forest algorithm. *Int. J. Eng. Trends Technol.* 69(5), 119–127. <https://doi.org/10.14445/22315381/IJETT-V69I5P217>
- Perrin, B. (2015). Bringing accountability up to date with the realities of public sector management in the 21st century. *Canadian Public Administration*, 58(1), 183-203. <https://doi.org/10.1111/capa.12107>
- Pessach, D., Singer, G., Avrahami, D., Ben-Gal, H. C., Shmueli, E., & Ben-Gal, I. (2020). Employees recruitment: A prescriptive analytics approach via machine learning and mathematical programming. *Decision Support Systems*, 134, 113290. <https://doi.org/10.1016/j.dss.2020.113290>
- Russell, C., & Bennett, N. (2015). Big data and talent management: Using hard data to make the soft stuff easy. *Business Horizons*, 58(3), 237-242. <https://doi.org/10.1016/j.bushor.2014.08.001>
- Ryan, J., & Herleman, H. (2015). A big data platform for workforce analytics. *The Data Science Revolution and Organizational Psychology*, p. 19.
- Sela, A., & Ben-Gal, H. C. (2018, December). Big data analysis of employee turnover in global media companies, google, facebook and others. In *2018 IEEE International Conference on the Science of Electrical Engineering in Israel (ICSEE)* (pp. 1-5). IEEE. <https://doi.org/10.1109/ICSEE.2018.8645991>
- Stone, D. L., Deadrick, D. L., Lukaszewski, K. M., & Johnson, R. (2015). The influence of technology on the future of human resource management. *Human resource management review*, 25(2), 216-231. <https://doi.org/10.1016/j.hrmr.2015.01.002>
- Strah, N., Rupp, D. E., & Morris, S. B. (2022). Job analysis and job classification for addressing pay inequality in organizations: Adjusting our methods within a shifting legal landscape. *Industrial and Organizational Psychology*, 15(1), 1-45. <https://doi.org/10.1017/iop.2021.94>
- Tanasescu, LG., Bologa, AR. (2022). Machine Learning and Data Mining Techniques for Human Resource Optimization Process—Employee Attrition. In: Ciurea, C., Boja, C., Pocatilu, P., Doinea, M. (eds) Education, Research and Business Technologies. Smart Innovation, Systems and Technologies, vol 276. Springer, Singapore. [https://doi.org/10.1007/978-981-16-8866-9\\_22](https://doi.org/10.1007/978-981-16-8866-9_22)
- Traicoff, D., Pope, A., Bloland, P., Lal, D., Bahl, J., Stewart, S., ... & Sandhu, H. (2019). Developing standardized competencies to strengthen immunization systems and workforce. *Vaccine*, 37(11), 1428-1435. <https://doi.org/10.1016/j.vaccine.2019.01.047>
- Wei, F. (2022). Performance evaluation of tourism human resource management based on fuzzy data mining. *Journal of Mathematics*, 2022. <https://doi.org/10.1155/2022/3745377>
- Wiedmer, T. (2015). Generations do differ: Best practices in leading traditionalists, boomers, and generations X, Y, and Z. *Delta Kappa Gamma Bulletin*, 82(1), 51.
- Xue, X., Feng, J., Gao, Y., Liu, M., Zhang, W., Sun, X., ... & Guo, S. (2019). Convolutional recurrent neural networks with a self-attention mechanism for personnel performance prediction. *Entropy*, 21(12), 1227. <https://doi.org/10.3390/e21121227>
- Ye, Y. (2022). Assistant Teaching System of Human Resource Management Course Based on Data Mining. In: Fu, W., Sun, G. (eds) e-Learning, e-Education, and Online Training. eLEOT 2022. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 453. Springer, Cham. [https://doi.org/10.1007/978-3-031-21161-4\\_21](https://doi.org/10.1007/978-3-031-21161-4_21)
- Zehir, C., Karaboğa, T., & Başar, D. (2020). The transformation of human resource management and its impact on overall business performance: big data analytics and AI technologies in strategic HRM. *Digital Business Strategies in Blockchain Ecosystems: Transformational Design and Future of Global Business*, 265-279. [https://doi.org/10.1007/978-3-030-29739-8\\_12](https://doi.org/10.1007/978-3-030-29739-8_12)
- Zhao, J., Wang, J., Sigdel, M., Zhang, B., Hoang, P., Liu, M., & Korayem, M. (2021). Embedding-based recommender system for job to candidate matching on scale. *arXiv preprint arXiv:2107.00221*.
- Zheng, F., Song, S., Xia, Y., Zhang, Y. (2023). Application of Fuzzy Data Mining Algorithm in Human Resource Management of Power Industry. In: Jan, M.A., Khan, F. (eds) Application of Big

Data, Blockchain, and Internet of Things for Education Informatization. BigIoT-EDU 2022. *Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering*, vol 467. Springer, Cham.  
[https://doi.org/10.1007/978-3-031-23944-1\\_61](https://doi.org/10.1007/978-3-031-23944-1_61)