



Algorithmic Human Resource Management: Characteristics, Possibilities and Challenges

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Abstract: *In the field of human resources, algorithmic management refers to the utilization of digital technology, artificial intelligence, and big data to develop rules and procedures that enable the automated management of human resources. Algorithmic human resource management can potentially replace human resource managers in all stages and activities of staffing, thereby significantly expediting the management process and enhancing cost-effectiveness. Through the use of artificial intelligence, algorithms develop patterns and models from which they can autonomously learn and improve the quality of decision-making in employee management. However, relying exclusively on algorithmic human resource management can lead to the emergence of discriminatory management practices, particularly when the algorithms are based on unrepresentative or biased data. Considering these factors, this paper aims to examine the fundamental characteristics, principles, application possibilities, and challenges of algorithmic human resource management.*

1. INTRODUCTION

Making business decisions has always occupied the attention of numerous authors. While the decision-making process is well-elaborated and clear, the same cannot be said for the decision-making process supported by modern digital technologies. Artificial intelligence, supported by a set of large volumes of data and machine learning, has led to a new way of making decisions, which is known as algorithmic decision-making. This approach to decision-making can be implemented in different business areas, thereby providing numerous advantages, but also challenges (Newell & Marabelli, 2015; Shrestha et al., 2019). An algorithm represents a decision-making process, or process of solving a problem, which is based on a set of certain rules and instructions for transforming inputs into outputs (Cheng et al., 2019; European Parliament, 2019). Algorithmic decision-making is usually based on the application of ICT and digital technology. Therefore, the entire decision-making process becomes automated and precise, since decisions are based on the results of the previous processing of a large volume of data (Köchling & Wehner, 2020; Lepri et al., 2018). Algorithmic decision-making, which in the context of the Fourth Industrial Revolution is integrated with artificial intelligence and machine learning, provides numerous opportunities for managers, certainly those who deal with human resources management. It is about the digital transformation of the human resources management function, where decisions are made based on extensive data and software solutions through complete or partial automation of the human resources management function (Meijerink et al., 2021). Thanks to the large volume of data and machine learning, a completely new form of knowledge is created, which is the intellectual capital of the organization. Based on such knowledge, HR managers can make effective decisions based on objective information, but can also predict future employee-related decisions and their effects. However, algorithmic decision-making has certain challenges and problems that should be taken into account (de Laat, 2018).

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Considering these factors, this paper aims to examine the fundamental characteristics, principles, application possibilities, and challenges of algorithmic human resource management. The work is divided into several relevant units. It is a theoretical analysis of a still limited number of works in the field of algorithmic human resource management (Jarrahi et al., 2021; Sienkiewicz, 2021). The initial section of the paper introduced the fundamental principles surrounding algorithmic human resource management. The subsequent segment delved into a comprehensive analysis of the core attributes inherent to this approach. Moving forward to the third section, the paper explored the viability of implementing algorithmic human resource management across various stages of the staffing process. Following this, a comprehensive overview of the benefits, challenges, and issues associated with the application of algorithmic human resource management was provided. This sequential structure has allowed for a systematic examination of the subject matter, facilitating a holistic understanding of the potentials and challenges posed by algorithmic human resource management in contemporary organizational contexts.

2. ALGORITHMIC HUMAN RESOURCE MANAGEMENT - BASIC CONCEPTS

Algorithmic decision-making and the application of information technology in human resource management (HRIS) are not new. However, their integrative application when managing human resources in the context of the Fourth Industrial Revolution is new. The fact that we live and work in the so-called “Information Era” creates opportunities to analyze and apply a large amount of data in order to improve decisions. Algorithms based on artificial intelligence scan and analyze millions of different data every day, turning them first into information and then into knowledge that can be used to make decisions (Cappelli & Rogovsky, 2023; Ranjbar, 2023; Shrestha et al., 2019). However, before delving into a more intricate examination of algorithmic human resource management, it is imperative to establish certain differentiations, primarily concerning HRIS. Both HRIS and e-HRM operate on the foundation of employing information and communication technology alongside data furnished by human resource managers. These systems are under the stewardship of managers and frequently lack autonomous learning capabilities or the capacity to generate novel insights. The complete spectrum of employee management remains within the purview of human resource managers who operate within the confines of existing data encapsulated within HRIS. This distinction lays the groundwork for comprehending the subsequent exploration into algorithmic human resource management, which signifies a departure from the conventional managerial landscape by introducing a level of autonomous decision-making and adaptability driven by algorithmic intelligence (Sienkiewicz, 2021). Concerning HRIS, algorithmic human resource management has the possibility of independent learning based on the provided data, which creates new information and an innovative form of organizational knowledge. Algorithms are often interconnected and use large and unstructured data, which ensures a special contribution to knowledge and decisions made. In particular, it should be emphasized that algorithmic human resource management can be fully automated. Unlike HRIS, the algorithm can completely replace human resource managers in certain activities (Parent-Rocheleau & Parker, 2022). This automation is particularly useful in the domain of administrative HR activities, as it gives HR managers enough space and time to deal with the complex strategic issues of employee management. Strategic human resource management is further powered by machine learning. Specifically, algorithmic human resource management entails the manipulation and application of information derived from the scrutiny of extensive quantities of unstructured data. Machine learning systems autonomously pinpoint a collection of attributes that are postulated to influence decision-making processes. Through supplementary analysis, combination, and assessment of these attributes, algorithms scrutinize

their effect on performance and decision quality. Consequently, these algorithms proffer optimal solutions to human resource managers. This paradigm reflects a dynamic cycle wherein these algorithms leverage evolving insights to continually refine their proposals, bridging the gap between data-driven insights and human managerial judgment. The crux of algorithmic human resource management rests on its capacity to navigate the intricacies of vast and unstructured data realms, ultimately fostering more informed, effective, and adaptive decision-making within human resource contexts (Shrestha et al., 2019).

Concerning HRIS, algorithmic human resource management uses data contained in various other systems and media of the organization, as well as outside it. This ensures the cross-functional connection of information, which significantly improves the comprehensiveness and quality of the decisions made (Leicht-Deobald et al., 2019). Human resource managers can access not only data related to employees' records or performance, but also information related to their interaction with customers, computer activities (search history, social media activity), GPS information, and so on (Bernhardt et al., 2021). If these data are collected and used ethically, following national and international ethical standards, an information base can be created that will significantly improve the quality of decisions made. Given the above, it can be noted that algorithmic human resource management is more than simple analysis in the use of employee data. Algorithmic human resources management is a system where algorithms that can learn independently make decisions based on statistical models and decision rules, with the explicit intervention of human resources managers (Sienkiewicz, 2021). Thanks to computer systems, the decision-making process becomes automated and capable of very quickly processing millions of different data and making large-scale decisions (Bucher et al., 2021).

Algorithmic human resource management is the effect of digital transformation and the integration of artificial intelligence and machine learning in human resource management. As such, algorithmic human resource management has three essential attributes. First, it is based on the use of digital data. Second, this data is analyzed within modern software and digital solutions. Third, the HR decision-making process can be fully or partially automated (Meijerink et al., 2021). The decision-making logic of the algorithm in human resource management is identical to any other algorithmic decision-making, i.e. it can be deterministic or probabilistic. In mathematics and computer science, most studies are based on the deterministic nature of decision-making, which is based on the assumption that if input A creates output B, then A will always be followed by B. The probabilistic relationship between input and output is based on the idea that the occurrence of A increases the probability of B. Because it is applied in conditions of imperfect knowledge of the relationship between inputs and outputs, human resource managers are often more interested in problems of a probabilistic nature. But, precisely because of limited knowledge, probabilistic algorithms will not always offer the correct solution. That is why human resource managers use a large volume of data, statistical models, and numerous software solutions when applying algorithmic human resource management (Cheng & Hackett, 2021).

3. CHARACTERISTICS OF ALGORITHMIC HUMAN RESOURCE MANAGEMENT

The digital transformation of business has created numerous changes in the field of human resource management. Among these changes, algorithmic human resource management stands out for its role in simplifying the process of talent identification within organizations. This particular capability has significantly contributed to the adoption of algorithmic human resource management by prominent enterprises such as Google, IBM, Microsoft, and others.

These industry leaders have embraced algorithmic approaches to human resources as a means to streamline and enhance their talent identification endeavors. By leveraging algorithms and data-driven insights, these organizations can discern and nurture potential talents more efficiently, aligning with their broader strategies for growth and innovation. This trend underscores the pivotal role that algorithmic human resource management plays in reshaping traditional talent management paradigms to suit the demands of the contemporary digital business landscape (Alvarez-Gutierrez et al., 2022; Köchling & Wehner, 2020).

There are three essential elements at the basis of algorithmic human resources management, as shown in Figure 1. These are artificial intelligence, predictive and prescriptive HR analytics, and evidence-based decision-making.

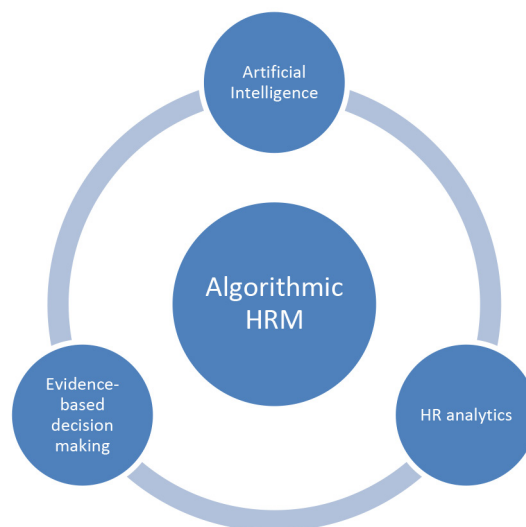


Figure 1. Basic foundations of algorithmic human resource management

Source: Sienkiewicz, 2021

The information used in algorithmic decision-making is provided by human resource managers. This information may be descriptive; but bearing in mind the fact that evidence-based decision-making models and artificial intelligence are based on a large volume of data, they must be both semi-structured and unstructured. Decision models based on artificial intelligence predict future activities and outcomes, while models of prescriptive analytics, based on a large volume of data, go a step further and provide additional information about the probability of certain events and their characteristics. Therefore, algorithmic human resource management requires machine learning and data mining in order to create patterns that will help in making HR decisions (Meijerink et al., 2021).

According to the above, it is possible to identify three types of algorithms in human resource management (Leicht-Deobald et al., 2019):

1. Descriptive algorithms: provide information about previously made decisions and their effects. Being based on historical data, descriptive algorithms are based on the application of simple statistics and provide information to human resource managers about the current motivation, satisfaction of employees, their performance, etc.
2. Predictive algorithms: they are based on the use of data on previously made decisions and achieved results, in order to predict them in the future. These algorithms use regression techniques, data mining, and machine learning.

3. Prescriptive algorithms: their task is to show different possible scenarios of decisions made. These algorithms transcend the realm of mere predictability because they provide information about the potential effects and characteristics of the decisions made. As such, prescriptive algorithms use the same models and techniques as predictive algorithms but add simulation techniques and scenario analysis.

Prescriptive algorithms are often used to improve the efficiency of employees since they predict the effects and different scenarios to make decisions on the behavior and productivity of employees (Parent-Rocheleau & Parker, 2022). For example, by employing prescriptive algorithms it is possible to monitor how different employee reward systems can affect their motivation, satisfaction, performance, and the like. An additional advantage is that these models operate with unstructured data, so it is possible to monitor the additional influence of socio-demographic and other characteristics of employees on the decisions made.

4. APPLICATION OF ALGORITHMIC HUMAN RESOURCE MANAGEMENT IN EMPLOYEE STAFFING

The basic application of algorithmic human resource management was first present in the domain of HR analytics, performance measurement and recruitment (eg resume parsing software). Over time, algorithmic models began to be used in order to improve the efficiency of employees, and today their automated application is noticeable in the process of employee recruitment, selection and development (Bernhardt et al., 2021). Based on the information contained in the systems and databases, which for example can relate to the level of demand and customer preferences, human resource managers can predict the required number of employees in the future with high precision, thus improving the human resources planning process. HR analytics helps employees predict their future behavior through clearer insights into employee information, primarily when it comes to motivation, retention and engagement. In addition, through HR analytics, it became much easier for managers to make decisions about the employees' career development (Jarrahi et al., 2021).

Algorithmic human resource management proves particularly advantageous in the realm of employee recruitment and selection. In the contemporary landscape, enterprises increasingly harness innovative recruitment approaches, prominently through online platforms and social networks. These digital avenues offer a distinct advantage through their utilization of referral systems. Employing a blend of inputted referral requests, historical search data, behavioral patterns, and candidate preferences, these digital platforms autonomously present candidates deemed suitable for organizational needs. This process mirrors marketing methodologies, enabling a finer level of precision in targeting desired candidates. By leveraging algorithmic insights, organizations can efficiently navigate the intricate realm of modern recruitment, swiftly connecting with potential talents that align with their specific requirements. This synergy between technology and human resource management underscores the transformative potential of algorithmic approaches in refining and optimizing the recruitment process to ensure the best possible candidate matches (Köchling & Wehner, 2020). Special systems and software solutions can analyze a large number of incoming applications and candidate resumes in a very short period and automatically reject those who do not meet any of the defined conditions. In addition to shortening the recruitment time, this also reduces recruitment costs (Cheng & Hackett, 2021). Efficiency and cost reduction are also evident in the selection process. Resume parsing systems and algorithmic evaluation of conducted interviews with candidates, as well as text mining, facilitate the selection of those candidates who meet the requirements according to various

criteria. Additionally, certain artificial intelligence systems can track verbal and non-verbal communication symbols (changes in voice tone and dynamics, facial expressions, body posture, and the like). It is Natural language processing, which represents a set of syntactic and semantic rules of algorithmic decision-making, i.e. comparison, extraction, analysis and use of information (Köchling & Wehner, 2020).

Algorithmic human resource management is also used for employee development. Thanks to HR analytics and a large volume of data, algorithms can easily present deficient employee knowledge that needs to be improved, with clearly defined and customized education programs. Algorithms can also predict the knowledge and skills that will be needed in the future based on the prediction of future demand (Cheng & Hackett, 2021). The information used in decision-making is not only based on personal files and previous performance of employees but also includes a benchmark with talents on the labor market. In addition, when planning employee development, algorithms often take into account the potential effect on motivation, retention and engagement, which is in line with the principles of prescriptive analytics (Köchling & Wehner, 2020).

A big advantage when managing human resources is that algorithms can use a large volume of different data about employees, especially when it comes to performance. Namely, algorithms do not only monitor the quantitative results achieved by employees, but also their emotions, social contacts, stress, and psycho-physical burnout, and then bring these variables into mutual relations in order to identify patterns and trends. Thanks to the large volume of data, algorithms can predict the future performance of employees much more easily and more precisely, while providing information to human resource managers on how to improve them (Parent-Rochelleau & Parker, 2022).

When it comes to the reward system, this area of algorithmic human resource management has been the least explored so far. If the reward system is linked to the performance and behavior of the employees, the algorithms can show when the rewards given to the employees led to specific positive or negative changes. Following such information, it is possible to design a reward system that is flexible and adapted to the needs of employees, which has a positive impact on performance, but also on employee motivation and engagement. For example, Google uses predictive algorithms to reduce employee attrition by analyzing when rewards should be given and how flexible the reward system must be (Cheng & Hackett, 2021).

5. POSSIBILITIES AND CHALLENGES OF ALGORITHMIC HUMAN RESOURCE MANAGEMENT

Algorithmic human resource management simultaneously provides various advantages, but also numerous challenges. In addition to shortening decision-making time and improving the decisions, algorithmic human resource management allows companies to more easily identify potential talent. Decisions made based on numerous information enable the minimization of risks, the increase of employee productivity, as well as an increase in the certainty of the outcome. In other words, the algorithmic management of human resources can provide a competitive advantage (Köchling & Wehner, 2020). Also, algorithmic human resource management significantly facilitates the monitoring of employees, which is especially useful for remote work (Jarrahi et al., 2021).

However, algorithmic human resource management also has certain challenges, which can potentially threaten its effectiveness. Namely, it is often stated that decisions made in this way are not transparent enough. In certain circumstances, algorithmic human resource management can lead

to discriminatory practices, certainly in the process of recruitment and career development (Meijerink et al., 2021). This happens in circumstances where there is low-quality input data. Algorithms work based on previously provided information. Therefore, if there is biased data, future decisions will not be objective. For example, if the manager entered data characterized by stereotype, incompleteness, or any other bad assessment, there is a risk that the decisions made will have the same character (Bujold et al., 2023; Köchling & Wehner, 2020; Rodgers et al., 2023). When managing human resources, these problems can lead to discrimination on any basis (race, gender, age, education, etc) (de Laat, 2018). Since the algorithms are based on data extrapolation, if the manager, for example, hires more men in the recruitment process, there is a risk that the system will recommend only male candidates in the future. One study shows that job vacancies on Facebook are primarily viewed by women (more than 85%), while ads for taxi drivers are predominantly viewed by men. The Uber tracking application, as part of the algorithmic human resource management, monitors the driver's GPS position, speed, stopping time, and heavy braking. The algorithm calculated lower earnings for women since they drove more slowly than men on the same route. The Amazon CV screening tool often decides to hire men, since the algorithm is based on historical data in which more decisions in the recruitment process were made to hire male engineers than female ones (Köchling & Wehner, 2020). Therefore, in order for algorithmic human resource management to give good results, it must be based on objective information. If you take Uber as an example, women may have driven more slowly than men, but the system did not take into account that there may have been fewer traffic accidents or damage to transported goods.

In addition to the problem of discrimination, the problem of privacy and data integrity often arises, since algorithms use a large volume of data to make decisions, many of which may be of a personal nature (European Parliament, 2019). A typical example is the use of Internet searching information, viewing profiles and activities on social networks, and the like. The problem of privacy also arises due to the continuous and facilitated monitoring of employees' devices (mobile phones and computers), since the system can monitor the employee's work, as well as his activities outside of working hours (Leicht-Deobald et al., 2019). This can consequently lead to information asymmetry, and a decrease in autonomy, motivation, and job satisfaction (Parent-Rocheleau & Parker, 2022).

Ultimately, it's crucial to recognize that the implementation of algorithmic human resource management, even when upholding ethical principles, is not without complexity. Given its nature as a digital transformation, HR managers must possess specialized knowledge and competencies that extend beyond conventional HR expertise. Additionally, addressing this requirement is challenging due to the scarcity of educators available for such training. Compounding this issue is the resource constraint, as implementing algorithmic human resource management can entail substantial costs. The adoption of algorithmic management introduces a paradigm shift that demands a new skill set among HR professionals, but limitations in both educational opportunities and financial resources pose obstacles to its seamless implementation. Navigating these challenges necessitates a concerted effort to bridge the knowledge gap, develop pertinent competencies, and secure the necessary resources to successfully harness the benefits of algorithmic human resource management while ensuring its ethical and effective application (Jarrahi et al., 2021).

6. CONCLUSION

Digital transformation has led to numerous advantages in the business of organizations, certainly when it comes to human resource management. The traditional approach to employee management must be replaced by an innovative one, in which artificial intelligence and machine

learning provide the basis for quality decision-making. Thanks to the large volume of data and HR analytics, artificial intelligence and machine learning systems create the basis of algorithmic human resources management.

The concept of algorithmic management has emerged as a transformative force in the realm of human resources. By leveraging digital technology, artificial intelligence, and big data, organizations can streamline and automate various aspects of human resource management. This holds the potential to revolutionize the traditional staffing processes, offering greater efficiency and cost-effectiveness. The utilization of algorithms, driven by artificial intelligence, empowers these systems to evolve and enhance decision-making in personnel management through continuous learning from patterns and models.

However, it is essential to acknowledge the potential pitfalls of overreliance on algorithmic human resource management. The risk of discriminatory practices looms when algorithms are founded on biased or inadequate data, underscoring the significance of maintaining human oversight to ensure fairness and ethical treatment. Striking a balance between the benefits of algorithmic efficiency and the necessity of human judgment remains a pivotal challenge. In navigating these complexities, organizations must prioritize a holistic approach that harnesses the power of algorithmic management while upholding values of inclusivity and fairness in the treatment of employees.

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