



APPLICATION OF ARTIFICIAL INTELLIGENCE IN WORKFORCE PLANNING IN THE FIELD OF HUMAN RESOURCES MANAGEMENT

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Abstract:

Workforce planning is one of the most critical functions of human resource management (HRM), requiring accurate forecasts of staffing needs, labor market analysis, and strategic alignment of organizational capacities with business objectives. In the last decade, artificial intelligence (AI) has dramatically transformed this process through the introduction of sophisticated tools for predictive analytics, natural language processing, and machine learning. The emergence of agentic AI, autonomous systems capable of reasoning and acting without continuous human oversight represents a further qualitative leap that is beginning to reshape how organizations approach workforce planning. This paper analyzes the ways in which AI technologies, including both generative and agentic AI systems, are changing traditional workforce planning practices, identifies key advantages and limitations, and discusses the ethical implications of applying algorithmic systems in the HRM domain. The research findings suggest that AI significantly increases the accuracy of staffing needs forecasting and reduces talent acquisition costs, while simultaneously generating new challenges regarding algorithmic bias, privacy protection, and the governance of autonomous decision-making.

Keywords:

Artificial Intelligence, Workforce Planning, Human Resources, Predictive Analytics, Machine Learning.

INTRODUCTION

Workforce planning has always represented a complex and multi-dimensional process that involves assessing an organization's current staffing capacities, forecasting future needs, and developing strategies to bridge the gap between labor supply and demand. In the era of digital transformation, this process is undergoing a fundamental paradigm shift, driven by the accelerated development and democratization of artificial intelligence tools.

Traditional approaches to workforce planning relied on static models based on historical data and the expert knowledge of HR professionals. However, the complexity of the modern labor market, rapid technological changes, and global organizational interdependence are making these methods increasingly inadequate.

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Research conducted by Vrontis et al. shows that more than 60% of HR directors in Fortune 500 companies believe that traditional workforce planning tools are no longer sufficient to address contemporary business challenges.[1]

Artificial intelligence, as a set of technologies encompassing machine learning (ML), natural language processing (NLP), deep learning, and predictive analytics, offers a revolutionary solution to these challenges. The ability of AI systems to process vast amounts of structured and unstructured data in real time, recognize hidden patterns, and generate precise forecasts fundamentally changes the nature of HR planning. Nevertheless, the application of AI in this domain is not without controversy; questions of algorithmic bias, transparency, and the ethics of algorithmic decision-making are emerging as central challenges for the research community and practitioners.

This paper aims to systematically review current literature on the application of AI in workforce planning, identify key patterns in the use of these technologies, and critically examine the advantages, limitations, and ethical implications of this trend. The paper is organized as follows: after the introduction, Chapter 2 analyzes specific applications of AI in workforce planning; Chapter 3 examines the benefits and documented effects of these technologies; Chapter 4 addresses limitations and ethical challenges; while Chapter 5 synthesizes conclusions and proposes directions for future research.

2. APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN WORKFORCE PLANNING

2.1. TALENT ANALYTICS AND PREDICTIVE FORECASTING OF STAFFING NEEDS

Talent analytics as a methodological approach that uses large data sets and advanced statistical methods for workforce management represents a key intersection between AI and HR planning. Nocker and Sena define talent analytics as a set of methodologies that enable organizations to identify patterns in workforce data in order to manage it, drive change, and create value. They particularly value organizations that can identify a causal relationship between training costs and profitability, as this enables evidence-based strategic workforce development planning rather than relying on mere intuition.[2]

Meijerink and Bondarouk propose the concept of the duality of algorithmic management as a central framework for understanding the relationship between HR algorithms and employee autonomy. The authors show that algorithmic systems simultaneously restrict employee autonomy through rigorous monitoring and expand it by automating administrative tasks which is a key insight for the design of AI-based workforce planning systems.[3]

A particularly interesting application is employee sentiment analysis through NLP techniques. Systems that automatically analyze anonymized employee feedback, internal communications, and satisfaction survey results are capable of detecting early signs of dissatisfaction and potential attrition, enabling HR managers to respond proactively. According to findings from Cheng and Hackett's study, organizations using NLP analytics to monitor employee satisfaction report a reduction in unexpected turnover of 18-22%.[4]

Predictive employee attrition models represent one of the most concrete and economically significant outcomes of talent analytics. These models integrate data from diverse sources: annual performance review results, absenteeism data, compensation information relative to market averages, length of service, and even patterns of internal IT system usage to predict with high accuracy which employees are at risk of leaving the organization in the next six to twelve months. Identifying these employees in advance gives HR managers valuable time to intervene through targeted retention measures: compensation adjustments, career development planning, or changes in the work environment. Cheng and Hackett emphasize, however, that without solid theoretical foundations, empirical research in this field remains fragmented and insufficiently practical, making it difficult for organizations to reliably assess whether a particular AI system will work in their specific context.[4]

2.2. CHATBOTS AND AUTOMATION OF RECRUITMENT PROCESSES

AI-based chatbots have transformed the front-end aspect of recruitment, interaction with candidates. Nawaz and Gomes systematically document how chatbots enable organizations to be available to candidates 24 hours a day, 7 days a week, which has direct implications for candidate experience and employer branding. Chatbots take over routine communication tasks: answering frequently asked questions, scheduling interviews, and providing feedback to candidates, freeing HR professionals for more complex and value-intensive activities.[5]



Allal-Cherif, Aranega, and Castano Sanchez provide a comprehensive analysis of how digital technologies, including AI, improve all phases of the recruitment process: from identifying candidates on social networks, through gamification of selection and chatbot interviews, to matching candidates and positions through advanced algorithms. The authors particularly highlight e-recruitment as a phenomenon that fundamentally changes the nature of the employer-candidate relationship.[6]

The study by Ore and Sposato, based on semi-structured interviews with ten professional recruiters in multinational corporations, reveals an ambivalent attitude among recruiters toward AI: on one hand, they recognize that AI effectively automates routine tasks; on the other hand, they express fear and distrust toward broad adoption of these technologies, partly driven by concern about job loss. The key conclusion of their research is that recruiters believe their jobs will remain relevant because the human dimension of recruitment remains irreplaceable.[7] Campion et al. document that organizations implementing AI-assisted screening processes report a reduction in "time to fill" positions of 40-60%, while simultaneously improving the quality of selection as measured by employee performance in the first year.[8]

2.3. INTELLIGENT TALENT MANAGEMENT AND CAREER PLANNING

Systems based on deep learning algorithms are capable of analyzing professional profiles on social networks such as LinkedIn, identifying candidates who are not actively on the job market but possess the required competencies, and predicting the likelihood of a new candidate's success based on analysis of previous employees' performance. This integration of external data with internal HR metrics fundamentally changes workforce planning practice. Vrontis et al. confirm that AI technologies are changing key HR functions including recruitment, selection, and talent management, but with the important caveat that positive effects often depend on organizational context, available resources, and the maturity of digital infrastructure.[1]

Allal-Cherif et al. particularly emphasize how AI expands the spectrum of e-recruitment toward talent management and retention, which is directly relevant to the strategic aspect of workforce planning.[6] AI-based personalized career planning systems analyze internal data on career trajectories of successful employees and generate individualized recommendations for compe-

tency development and internal transfer opportunities. In this way, AI not only helps attract new talent, but actively contributes to retaining and developing the existing workforce which, in conditions of growing qualified labor shortages in many industries, has become equally important as recruitment itself.

2.4. SCHEDULING OPTIMIZATION AND WORKLOAD MANAGEMENT

Artificial intelligence also finds application in the operational aspect of workforce planning, specifically in optimizing work schedules and managing workloads. Scheduling optimization algorithms, based on operations research techniques and reinforcement learning, are capable of simultaneously considering dozens of constraints: legal regulations on working hours, individual employee preferences, predicted departmental workloads, competencies required for specific tasks, and overtime costs. Jerman et al., in a study conducted in the healthcare sector, demonstrate that applying ML-based scheduling systems for medical staff leads to a reduction in labor costs of 12-18%, while simultaneously improving employee satisfaction due to a fair and transparent scheduling process.[9] In the retail sector, algorithms that combine historical transaction data, local events, and seasonal trends are capable of generating highly accurate forecasts of staffing needs. Beyond reactive scheduling, AI systems are increasingly being used for proactive workload management; by analyzing productivity and absenteeism patterns, algorithms can identify teams experiencing chronic overload and generate resource redistribution recommendations before that overload results in increased turnover or a decline in work quality.

2.5. AGENTIC AI: BEYOND GENERATIVE SYSTEMS

The AI technologies described in the preceding sections, predictive analytics, NLP-based chatbots, and scheduling algorithms predominantly belong to the category of generative or reactive AI systems, which respond to explicit human prompts or operate within predefined parameters. A qualitatively new paradigm, known as Agentic AI, represents a fundamental advancement beyond these approaches. Jovanović et al. define agentic AI as an autonomous or semi-autonomous software entity that can process data, form decisions, and take actions in the digital and physical world without relying on continuous human oversight. Un-



like chatbots that simply generate responses based on pre-learned patterns, agentic AI systems continuously monitor their environment, autonomously make informed decisions, execute multi-step actions, and learn from their experiences and mistakes[10].

The distinction between generative AI and agentic AI is critical for understanding the trajectory of AI in workforce planning. Shirazi et al. provide a comprehensive review of agentic AI systems, defining them as going beyond traditional AI and generative AI by focusing on autonomy, adaptability, and goal-driven reasoning. Their analysis of 143 primary studies identifies five key behavioral patterns that define agentic systems: tool use, reflection, reasoning-and-acting (ReAct), planning, and multi-agent collaboration. These systems do not merely execute commands; they actively plan, learn from environmental feedback, and orchestrate sequences of actions to achieve complex, long-horizon goals[11]. In the HR context, this means that an agentic AI system could autonomously conduct end-to-end recruitment, from identifying candidates and scheduling interviews to evaluating performance data and generating onboarding materials without a human prompting each individual step.

Kausar et al., in a survey published in IEEE Xplore, characterize agentic AI as an emerging paradigm of autonomous systems designed to pursue complex goals with minimal human intervention, demonstrating adaptability, advanced decision-making capabilities, and self-sufficiency that enable it to operate dynamically in evolving environments. This is in sharp contrast to traditional AI, which depends on structured instructions and close oversight[12]. For strategic workforce planning, this autonomy translates into a transition from static, human-driven planning cycles to dynamic, activity-based models in which agents continuously ingest workforce, business, and market data to run planning scenarios, build skill forecasts, and detect gaps in talent strategies in real time.

According to Jovanović et al., industry projections indicate that agentic AI will find its way into 33% of enterprise software applications by 2028, replacing 20% of human interactions and making 15% of day-to-day workplace decisions. The global market for agentic AI is projected to reach \$120 billion by 2030, driven by accelerating investments across industries[10]. In the HR domain specifically, the paper documents concrete applications of agentic systems: talent management agents that analyze employee performance data, identify skill gaps, and recommend personalized development plans, as well as employee engagement agents that monitor sat-

isfaction through sentiment analysis and suggest proactive interventions to reduce turnover. These applications represent a significant qualitative leap beyond the reactive AI tools discussed in previous sections, as they operate continuously without human triggers and can coordinate multiple complex sub-tasks simultaneously.

The ethical implications of agentic AI in HRM are substantially different from those of generative AI. When an autonomous agent makes a hiring recommendation or initiates a performance review process without human prompting, the accountability chain becomes considerably more complex. Jovanović et al. emphasize that with the great power of agentic AI comes significant responsibility, and that senior leaders must actively address the ethical implications and risks associated with mass agentic AI adoption, including the need to address biases, ensure ethical use, and establish robust regulatory frameworks[10]. This concern is amplified in the HR context by the requirements of the EU AI Act, which classifies HR decision-support systems as high-risk applications requiring mandatory human oversight, a requirement that becomes structurally challenging when the AI system itself is designed to operate autonomously.

3. ADVANTAGES AND LIMITATIONS OF AI APPLICATION

3.1. DOCUMENTED ADVANTAGES

Based on a synthesis of the analyzed literature, it is possible to identify four consistently documented categories of advantages of applying AI in workforce planning.

- Increased accuracy in forecasting staffing needs and turnover. Nocker and Sena show that organizations with mature talent analytics practices report an average of 5% higher productivity than their competitors [2]. More accurate forecasts of staffing needs directly reduce costs associated with overstaffing or understaffing, and thus overall operating costs.
- Acceleration and cost reduction of recruitment processes. Nawaz and Gomes document that AI-based chatbots drastically reduce response times to candidate inquiries and relieve HR teams from routine administrative tasks[5]. Allal-Cherif et al. confirm that intelligent e-recruitment accelerates talent identification, selection, and onboarding while simultaneously expanding the geographical reach of searches[6].



- Reduction of subjective bias in selection. When properly designed and validated, algorithmic systems can reduce certain forms of bias associated with human decision-making. Ore and Sposato, based on interviews with professional recruiters, confirm that recruiters recognize this advantage of AI, with the important caveat that it does not exclude the possibility of a new, algorithmic form of bias.[7]
- Strategic repositioning of the HR function. By automating routine tasks, AI frees HR professionals for higher-level strategic activities. This transformation of the HR role is documented in the study by Ransbotham et al., who show that organizations with a high degree of AI adoption in HR functions report greater satisfaction among HR professionals with their own work and a greater perceived strategic impact of the HR team.[13]

3.2. STRUCTURAL LIMITATIONS

Tambe et al. identify four fundamental limitations of applying AI in HR, which remain relevant despite rapid technological progress. [14]

- First, the complexity of HR phenomena: unlike technical systems, HR processes are characterized by causal mechanisms that are extremely difficult to model. It is difficult to precisely define, let alone quantify, everything that makes a good employee for a specific position in a specific organizational context.
- Second, the problem of small data sets: many organizations do not have sufficient historical data for training robust ML models, especially for rare but strategically critical positions. Cheng and Hackett emphasize that data quality in HR domains is often compromised; the same job can be described in different ways, competencies are measured differently, and employee performance is rarely systematically and objectively documented. [4]
- Third, issues of fairness and legal compliance are particularly pronounced in the context of the EU AI Act (2024).
- Fourth, negative employee reactions, fear of job loss, and distrust of algorithmic decision-making can sabotage the potential benefits of AI systems, as empirically documented by Ore and Sposato. [7] A particular challenge is the black box problem: HR professionals using recommendations

from deep neural networks face the fundamental question of how to justify a hiring or dismissal decision based on a recommendation from a system whose internal workings cannot be fully understood. Cheng and Hackett also point to a serious theoretical gap that limits progress in this area: despite the rapid growth of empirical research, there is a lack of a coherent theoretical framework to explain the mechanisms through which algorithmic systems affect outcomes for employees and organizations. Without solid theoretical foundations, empirical research remains fragmented and insufficiently practical, making it difficult for organizations to reliably assess the effectiveness of AI systems in their specific environment.[4]

4. ETHICAL CHALLENGES: ALGORITHMIC BIAS, PRIVACY, AND REGULATIONS

4.1. ALGORITHMIC BIAS AS A SYSTEMIC PROBLEM

The most serious ethical challenge of applying AI in HR planning is the problem of algorithmic bias. AI systems learn from historical data, and if that data reflects previous discriminatory practices in an organization or society, the model will learn and reproduce those biases. A well-known example is Amazon's internal recruitment algorithm, which had to be withdrawn in 2018. after it was found to systematically discriminate against female candidates, because the model had been trained on data about previous employees in which men predominated.

Raghavan et al., in one of the most influential papers in this field, systematically document the practices of 18 vendors of algorithmic applicant pre-screening and conclude that, despite growing interest in debiasing algorithmic systems, little is known about how methods are actually applied in practice. The authors identify the main methodological problem: different mathematical definitions of fairness are logically incompatible with each other, meaning that simultaneous optimization of all criteria for a fair algorithm is mathematically impossible.[15] Furthermore, other authors emphasize that simply removing protected attributes (gender, age, ethnicity) from the model is insufficient because the model can learn to use proxy variables to reconstruct these attributes.[16]

Vrontis et al. warn that AI systems learning from historical HR data inevitably reproduce discriminatory patterns that were present in that data.[1] Meijerink



and Bondarouk offer a complementary insight: bias is not merely a statistical but also a structural problem that reflects and reproduces organizational power dynamics and inequalities, making it particularly difficult to resolve through purely technical approaches.[3] Ore and Sposato empirically document that recruiters themselves express distrust of AI due to fear of unfair outcomes even among those who work daily with AI recruitment tools, there is skepticism about their ability to make objective and fair decisions.[7]

4.2. PRIVACY PROTECTION AND REGULATORY FRAMEWORK

The application of AI in HR planning involves the collection and processing of increasingly extensive sets of personal data. Tambe et al. highlight the transparency paradox: the more personalized an AI system an organization wants, the more personal data it must collect, proportionally increasing privacy risks for employees.[14] Allal-Cherif et al. highlight ethical questions related to social network analysis for candidate identification and selection purposes, a practice that is in a grey area regarding legality and data subject consent in most jurisdictions.[6]

The EU Artificial Intelligence Act (AI Act), which entered into force in 2024, explicitly classifies HR applications of AI as high-risk applications subject to stricter requirements for human oversight, transparency, and documentation. Annex III of the AI Act explicitly classifies as high-risk: systems for screening candidates and ranking job applications, systems for assessing work performance, systems for making decisions on promotions and dismissals, and systems for monitoring and evaluating employees. Nocker and Sena recommend that organizations develop talent analytics gradually, starting from clearly defined business questions, with strict adherence to ethical and legal frameworks and with active employee involvement in the design and validation of systems that potentially affect their careers and employment status[2].

The practical implications of the regulatory framework for organizations are far-reaching. For a specific application such as an ATS system with a candidate scoring algorithm, the AI Act provides for mandatory risk assessment prior to implementation, maintaining records of all significant decisions, and the right of candidates to request human review of an algorithmic decision (Art. 86). Failure to comply carries financial penalties of up to 30 million euros or 6% of global annual revenue, as well as reputational risks that may be

equally costly in the long term. Compliance with these requirements should therefore be viewed as an investment in building trust among employees and candidates in organizational HR practices.

5. CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

The application of artificial intelligence in workforce planning represents one of the most dynamic and significant areas of development in contemporary HR science and practice. The analyzed literature consistently documents significant advantages of AI systems, from increased accuracy in forecasting staffing needs and acceleration of HR processes, to reduced subjectivity in selection and strategic reorientation of the HR function. At the same time, the empirical evidence equally clearly points to serious limitations and risks that accompany these technologies.

The question of algorithmic fairness and transparency deserves special attention. Regulatory frameworks, such as the EU AI Act which classifies certain HR applications of AI as high-risk, set new requirements for organizations implementing these technologies. The development of explainable artificial intelligence (XAI) methods in the HR context therefore represents one of the priority directions for future research. Authors such as Vrontis et al. and Champion et al. converge on the conclusion that optimal application of AI in HR planning does not mean replacing human judgment with algorithmic judgment, but rather their synergistic combination. AI systems are exceptionally powerful in processing structured data and identifying statistical patterns, but remain limited in understanding organizational context, cultural nuances, and the ethical implications of HR decisions, areas where experienced HR professionals still play a key role.

For future research, we recommend:

- (1) longitudinal studies that track the long-term effects of AI adoption in HR functions, including impacts on organizational culture and employee satisfaction;
- (2) the development of standardized metrics for measuring algorithmic fairness in the HR context;
- (3) comparative studies examining differences in the effectiveness of AI systems across industries, cultural contexts, and organizational sizes; and
- (4) research on the effects of AI on the HR profession itself and the competencies required of future HR professionals.



5.1. RECOMMENDATIONS FOR KEY STAKEHOLDERS

For the potential of AI in workforce planning to be realized in a responsible and sustainable way, coordinated action by various stakeholders is necessary: educational institutions, the state, the research community, and the HR profession.

Educational institutions that train future HR professionals face an urgent need for curriculum reform. This includes introducing subjects covering the basics of machine learning and predictive analytics adapted to the HR context, as well as the ethics of algorithmic decision-making, GDPR fundamentals, and the requirements of the EU AI Act. Article 4 of the EU AI Act explicitly provides for the obligation to ensure AI literacy for all entities working with AI systems, which directly obligates academic institutions to equip students for critical assessment and responsible use of these tools. Beyond curricular changes, faculties should develop interdisciplinary research centers that bring together expertise from law, ethics, psychology, and computer science in one place, as a purely technical approach is insufficient to address challenges such as algorithmic bias.

The Republic of Serbia, as an EU candidate country, faces the necessary harmonization of its domestic regulatory framework with the EU AI Act. Concrete steps the state should take include: adopting specific national legislation regulating the use of automated systems in HR decision-making, including employees' right to an explanation of decisions and the right to human oversight; strengthening the capacities of the Commissioner for Information of Public Importance and Personal Data Protection; establishing a system of subsidies and tax incentives for small and medium enterprises investing in certified AI solutions; and launching a national platform for sharing anonymized HR data between organizations, under strict privacy protection conditions.

The research community should focus on developing and validating XAI methods adapted to HR decisions, developing Serbian-language NLP models that understand the context of the domestic labor market, and operationalizing the concept of algorithmic fairness in the context of Serbian anti-discrimination legislation. For HR professionals, Article 14 of the EU AI Act requires human oversight as a mandatory element of high-risk systems, which means that HR professionals formally become an indispensable link in the chain of responsibility for every significant personnel decision involving AI. Organizations must establish formalized procedures for reviewing algorithmic recommendations, document

each such decision, and ensure that employees are informed when a decision was made with the assistance of algorithms.

The conclusion is that artificial intelligence does not represent a universal solution to the challenges of workforce planning, but when applied thoughtfully, ethically, and with an adequate understanding of its capabilities and limitations, it can fundamentally improve an organization's ability to attract, develop, and retain the talent necessary for long-term business success. The EU AI Act is not an obstacle to innovation, but a framework that compels stakeholders to act in a coordinated and responsible manner. The Serbian HR and IT community should embrace it as the foundation for building credible, fair, and long-term sustainable AI-based workforce planning practices.

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