



Collaboration among recruiters and artificial intelligence: removing human prejudices in employment

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Abstract

In the global war for talent, traditional recruiting methods are failing to cope with the talent competition, so employers need the right recruiting tools to fill open positions. First, we explore how talent acquisition has transitioned from digital 1.0 to 3.0 (AI-enabled) as the digital tool redesigns business. The technology of artificial intelligence has facilitated the daily work of recruiters and improved recruitment efficiency. Further, the study analyzes that AI plays an important role in each stage of recruitment, such as recruitment promotion, job search, application, screening, assessment, and coordination. Next, after interviewing with AI recruitment stakeholders (recruiters, managers, and applicants), the study discusses their acceptance criteria for each recruitment stage; stakeholders also raised concerns about AI recruitment. Finally, we suggest that managers need to be concerned about the cost of AI recruitment, legal privacy, recruitment bias, and the possibility of replacing recruiters. Overall, the study answers the following questions: (1) How artificial intelligence is used in various stages of the recruitment process. (2) Stakeholder (applicants, recruiters, managers) perceptions of AI application in recruitment. (3) Suggestions for managers to adopt AI in recruitment. In general, the discussion will contribute to the study of the use of AI in recruitment, as well as providing recommendations for implementing AI recruitment in practice.

Keywords Collaboration · Recruiters · Artificial intelligence · Human prejudices · Employment

1 Introduction

Traditionally, organizations use lower technical approaches, for example, newspaper ads or referrals from employees, to draw in qualified applicants (Singh and Finn 2003). Traditional recruitment methods are now less efficient because it involves a substantial investment of time and does not always lead to optimal results (Ahmed and Reviews 2018; Edwards and Journal 2016).

Since the late 1990s, the labor market began to face economic challenges that witnessed a high demand for highly skilled candidates (Abou Hamdan 2019). If organizations need to meet the needs of their customers in this competitive technological advantage, it is only possible by hiring talent (Nawaz and Engineering 2019). Hiring has changed from an essential human resource initiative to a major strategic

concern for organizations because of the shift in talent as a provider of value and commercial advantage. In recent times, organizations have ranked attracting, selecting, and retaining talents as the primary strategic focus (Black and van Esch 2020b, a). At this time, e-recruitment systems are gradually growing, surpassing traditional methods (Enăchescu 2016).

The use of AI tools becomes popular for recruiters in 2018 (Upadhyay and Khandelwal 2018). Talent selection must be carried out carefully for companies to ensure that organizational goals are reached. The determination associated with talent selection is a challenging task because it is restricted to the decision maker's numeracy, vision, analytical skills, and internal bias (Abou Hamdan 2019). The new era of recruitment with the strength of artificial intelligence is enabling employers to tackle the challenges of hiring.

The COVID-19 outbreak in 2020, offices are locked down, physical distance is maintained between people, and masks are worn. Because of the virtual office, traditional work methods are not as effective. While the virtual office offers a great deal of flexibility, it also poses several challenges for HR recruitment. These include how to schedule interviews, select the right candidates, and attract people

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to submit their resumes while avoiding face-to-face contact between people (Pan and Zhang 2020). We can use artificial intelligence to solve the challenges because AI can provide various services related to HRM practices (Chattopadhyay and Technology 2020).

Today, companies are embarking on implementing “Digital Recruiting 3.0”. The shift crux is the AI application in the recruiting process (Black and van Esch 2020b, a). In any case, with AI, recruiters may handle large amounts of information to search for the right candidate. With AI support, recruiters also can reach beyond a candidate's personality traits and traditional resume to see whether it is a suitable match. Artificial intelligence is impartial and treats all candidates equally when screening resumes (Upadhyay & Khandelwal 2018). Its prevalence is based on the idea that AI recruiting tools can create a fair process and help achieve high-quality and optimal results in less time and cost than humans (Solascasas Morales 2020). AI system is revolutionizing the recruiting task by replacing the repetitive duties which were traditionally executed by professional recruiters in the past.

However, possible conflicts of shared control between humans and autonomous systems. For example, the conflicts that may arise when drivers interact with AI-based support. Therefore, the interaction between AI and humans in different application domains must be extended with state-of-the-art technology. Competence-Availability-Possibility-to-act (CAP) defines shared control scenarios (Vanderhaegen 2021). CAP-based autonomy is decomposed into several scenarios of shared control within or between workspaces. A car driving application validates the relevance of the approach.

2 Background

2.1 The definition of artificial intelligence

The idea of artificial intelligence was started during the Second World War by the British mathematician and computer scientist Alan Turing. In 1950, Alan Turing pointed out that if the person working with a machine does not know whether he or she is interacting with the machine, then he or she will assume that it is intelligent (Stuart and Peter 2016). The term “artificial intelligence” was coined by John McCarthy in 1956. McCarthy and his colleagues drafted a proposal to the Rockefeller Foundation to fund their project to explore “the possibilities of intelligent machine implementation”. The term “artificial intelligence” first appeared in this proposal (Jain and Research 2018).

However, a more comprehensive definition of artificial intelligence is possible. Artificial intelligence is a science that aims to design systems that can think like a human, have

the ability to learn, and perform tasks that require human intelligence (Balaban and Kartal 2015). The purpose of doing is to enable human actions to be accomplished by machines as well, such as perceiving, remembering, recalling, understanding, deducing, comparing, making decisions, thinking, making suggestions, or taking action (Shabbir and Anwer 2018). Artificial intelligence also shows how our brain works, and it is an expression of the code stored in our neurons (Palm 2012).

2.2 AI Categories and contributions on cognitive workload

There are three kinds of AI. Artificial Narrow Intelligence (ANI). This category of artificial intelligence, narrowly referred to as weak AI, focused on a specific product, service, or job (Frank et al. 2019); Artificial General Intelligence (AGI). The ability of this type of AI to mimic human cognitive activity is indistinguishable from humans (Strelkova 2017); Artificial Super Intelligence (ASI). Super-artificial intelligence does not only imitate human intelligence, but it has more intelligence than human systems. What currently exists is a narrow AI, but it will accumulate data in the next decade also with the rapid generation of other types of AI.

Identifying the user's cognitive workload is often used as a fundamental concern in human–computer systems when research focuses on “AI-specific” work. Humans have a limited capacity for processing information, such as short-term memory in the brain, thus we frequently use our surroundings to lighten our cognitive burden (Wilson 2002). AI assists humans in problem-solving and transfers human cognitive effort to the “global brain” (Barsalou 2014).

For the goal of adaptation and personalization, information systems specifically examine cognitive effort in the area of human–computer interaction (Ren et al. 2012). Some researchers employ user perception to examine the cognitive workload of users and its variations (Gupta et al. 2013). Higher AI support often helps users work less cognitively. Job seekers with professional work experience were encouraged to role-play applying for a job in an interview scenario set up by Buettner (2013). The users in systems with greater AI help experienced lower levels of cognitive burden, according to the results of simulated interviews.

Therefore, AI has some contribution to reducing human cognitive workload.

2.3 Deep learning and neural network method

A neural network is a type of computer model that uses a lot of artificial neurons connected together to simulate the structure and operation of a biological neural network. Neural network-based target identification methods are extremely

desirable in the deep learning era. Deep learning aims to educate computers to perform tasks that come naturally to people. Deep learning, which enables autonomous cars to recognize stop signs and tell pedestrians from street light posts, is also a critical technology.

In deep learning, computer models learn directly from images, text, or sound how to perform classification tasks directly. Deep learning models can achieve the highest levels of accuracy, sometimes even exceeding that of humans. We typically train models using a large amount of labeled data and a neural network architecture containing many layers.

Neural network learning is closely related to the way we normally learn. We first complete a certain amount of work and get corrected by a trainer to do that work in a better way the next time. Using the difference between the actual value and the predicted value, an error value is calculated and sent back to the system. The error is examined for each layer of the network and utilized to modify the threshold and weights for the following input. The closer the actual value is to the projected value, the less the error. Thus as the network continues to learn, the error decreases with each run. This process is called backward propagation and is carried

out continuously through the network until the error value is kept to a minimum.

In Fig. 1 above, the four variables listed (e.g., basic information of the applicant's experience, education, skills, responsibilities, etc.) are connected to the neurons via synapses. First, the system feeds new data into the input layer. In the hidden layers 1 and 2, respectively, calculate the node value. In the output layer, it calculates the output value and using the difference between the actual value and the predicted value, it calculates the value error and sends it back to the system (reverse propagation). This way, as the network continues to learn, the error is reduced for each run.

New technologies of the future bring a whole new imagination to existing information processing and artificial intelligence techniques, such as quantum computing. Quantum AI has led to the application of quantum computers in the field of artificial intelligence. Unlike the binary system processing used in classical computers, the base-3 system is introduced in quantum computers. In quantum computers, it is possible to select not only 1 or 0 bits but also both 1 and 0, resulting in a third state. As a result, the processing power of quantum computers is greatly improved. It can add

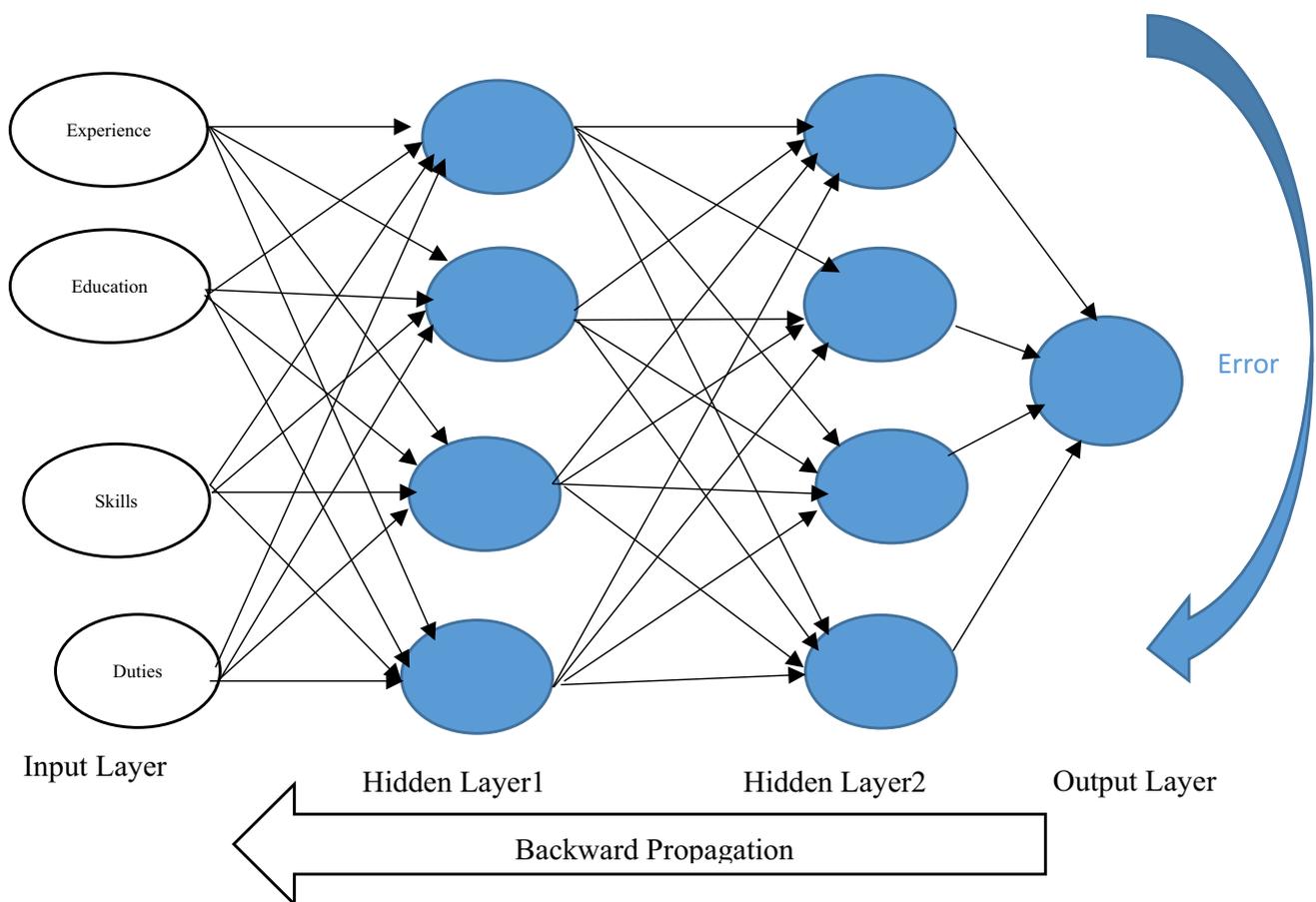


Fig. 1 Deep learning and neural network

the possibility of extreme computing power to AI. Quantum AI, as a field of interfusion between quantum computing and artificial intelligence, this direction can make both disciplines complement each other. Artificial intelligence can take advantage of the information processing of quantum computing to promote new types of AI algorithms, while quantum science can take advantage of deep learning techniques to achieve better manipulation of microscopic systems.

2.4 Human–AI interaction process and usefulness

Process automation enabled by robotics means automating work that operates according to processes with strong rules and a large number of recurring occurrences. In the recruitment field, intelligent automation technologies, comparable to mimicking the collaborative work of humans, lead to more complex recruitment tasks and settle in richer recruitment scenarios. To achieve intelligent robotics in the recruitment field, such as automatic recruitment, resume screening, interview chatbot, and smart interview scoring, it is not enough to rely on computer technology alone, but AI technology is needed to complete the “perception—cognition—execution” closed loop of human–AI interaction. AI technology includes natural language processing (NLP), optical character recognition (OCR), chatbot, intelligent decision-making, etc. AI technology may assist in providing business solutions, operations scheduling, and QC functions. Follow Fig. 2 illustrates human–AI interactions and usefulness in the recruiting field.

Most of the human–AI interaction is performed through perception, including visual, auditory, and tactile information. Cognition mainly involves human cognitive processing (e.g., thinking, decision-making, learning), including

experience cognition and thought cognition. Human–AI interaction interface design cannot be separated from human perception and cognitive characteristics. During the implementation process, defects are found through user feedback to improve the human–AI interaction.

The robot works in an open environment and serves ordinary users such as job seekers or recruiters who expect flexible interaction rules. There are many uncertainties in the overall human–AI interaction process, and AI algorithms need to be combined with other technologies (e.g., Machine Sensing, Mechatronics) to meet users' expectations of intelligent robots. Further, Human–AI interaction can fully utilize humans as a general intelligence to compensate for AI through robot's mobility and active interaction capability. AI's interaction capability can significantly improve the overall service capability and promote the wide application of intelligent robots in the recruitment field. In future, with the improvement of algorithm capability and hardware technology, AI applications in the recruitment field will gradually expand.

2.5 Digitalization of recruitment: from 1.0 to 3.0 era

Before the mid to late 90s, typically, Job seekers must search for opportunities on job boards or in the newspaper (Black and Esch 2020b, a). Once they find a suitable job, they usually have to come to the company that posted the job opportunity, acquire a job application form, fill it out manually, and hand it in. However, it is difficult for information in job advertisements to reach all interested job seekers and the recruitment process makes recruiters vulnerable to cognitive biases. In addition, the number and speed of recruiting performed by human recruiters cannot be compared with AI (Judge et al. 2000).

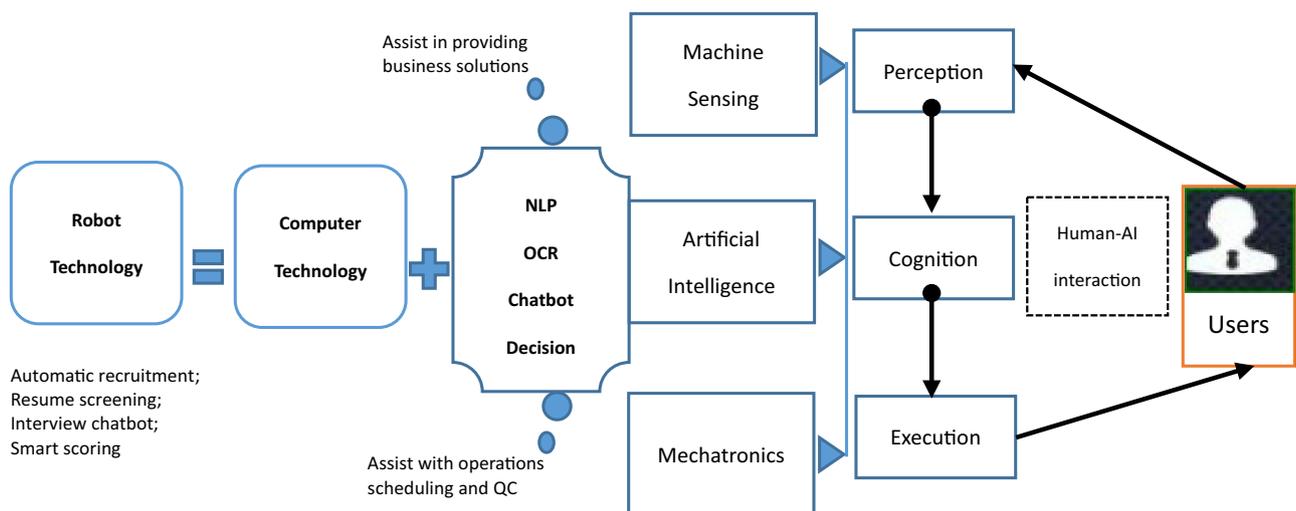


Fig. 2 Human–AI interaction process and usefulness

Digital Recruitment 1.0 era. In the mid to late 1990s, the way the Internet digitized work and candidate information breached the previous boundaries of information scope and richness (Black and Esch 2020b, a). A rich job description can be delivered to many potential employees with the least cost, as it does not require printing or shipping newspapers. Job seekers also do not need to search for print job information or take the time to mail many application forms.

Digital Recruitment 2.0 era. Emerging ten years after Digital Recruitment 1.0 era began, it can afford to aggregate job postings on multiple independent job websites (Black and Esch 2020b, a). Job seekers do not have to visit and search every job board, and recruiters can find distinct job seekers across all job platforms, and they do not need to post job information on every platform.

By 2015, with the increasing maturity of the Digital Recruitment 2.0 era, the Digital Recruitment 3.0 era has also been commercially applied. The emergence of the AI system has been a major feature of the Digital Recruitment 3.0 era (Kaplan and S 2018). AI software can understand speech, analyze emotions, recognize pictures, and then make decisions based on different criteria (Ahmed and Reviews 2018). Artificial intelligence software can automate recruitment tasks through algorithms. Algorithms and machine learning tools can quickly ingest data and identify patterns (Chichester Jr and Giffen 2019).

Background factors for the emergence of Digital Recruiting 3.0 include:

1. The incredible number of applications that Digital Recruitment 1.0 era and 2.0 era caused for each position (Maurer and Liu 2007). A dramatic drop in the cost of applying for jobs and a surge in the number of applicants for each position forced companies to spend more time reviewing all new applicants.
2. There is widespread acceptance of the importance of talent. Research is also beginning to prove that high-quality talent can make a competitive difference when tangible assets are the primary source of a company's value (Paschen et al. 2020). This difference proves that

finding the right candidate among a large pool of applicants is critical.

As a whole, these intelligent “people” of the 3.0 Recruiting Era have transformed the traditional recruiting function. AI can help companies identify talented applicants and hire those who meet the job (People-Job Fit) and organizational (People-Organization Fit) requirements (Kristof-Brown 2010). It offers increasing advantages and potential for human resource management (HRM) by reducing and almost eliminating friction in the “job finding” and “people finding” processes.

3 Application of AI in the recruitment stage

The recruiting procedure is considered a business one, in line with Davenport and Short. It covers every path of a candidate (Davenport and Short 1990). Artificial intelligence recruitment tools are used for six general activities: job advertisement, job search, application, selection, assessment, and coordination (Black and Esch 2020b, a).

In the job advertisement promotion stage, companies try to identify candidates and present them with job opportunities. Faced with a multitude of job opportunities, artificial intelligence can help applicants analyze the entire career path and filter out the appropriate results from the career web portals (Laurim et al. 2021). Applicants may be required to fill out an electronic application form or send an electronic resume. After the applicants submit the applications, AI tools begin screening and assessing them. If candidates pass the preliminary screening and assessment, the employer needs to evaluate the candidates to decide who is the best fit for the position. The phase may include more than one round of evaluation, but the final goal is to find who is the best candidate. AI also may be leveraged to coordinate with candidates throughout the recruitment stage.

Table 1 illustrates how AI can support the interaction between the candidates and the company during the recruiting stage.

Table 1 The application of artificial intelligence tools in recruiting stage

Recruitment stage	AI application
Job advertisements	Recruiters can develop appropriate job ads and control online channels with the support of artificial intelligence to increase the total number of applicants and identify more suitable candidates
Job searching	AI tool may assist the job seeker to find a suitable job based on skills, geographical, and demographic data
Application	Application guides and digital helpers could handle the task of writing job applications for applicants
Selection	Resume analysis presents applicant data to the company in the best possible way. Artificial intelligence tools analyze the application and assess candidates and, thus, decide the match of a candidate
Assessment	Gamified tests and recorded videos may be assessed by AI for candidates
Coordination?	A self-learning chatbot could answer some questions of applicants or propose a suitable job

3.1 Recruitment promotion

Job descriptions for ads posting can be completed with the help of artificial intelligence. It can help in developing job descriptions and specifications. Organizations can use artificial intelligence to update job descriptions to match the work being performed (People-Job Fit) (Kristof-Brown 2010).

The company needs to find the most suitable candidate, so the recruitment promotion advertisement needs to be broad and specific. Companies hope to reach suitable and active applicants. However, most are not actively looking for work. In a sense, they are passive candidates. Usually, the number of passive candidates exceeds the number of active candidates. However, passive candidates will still consider a suitable work opportunity if it takes the initiative to show them (Smith and Kidder 2010).

As the AI service accumulates experience, the AI tool may learn what external channels are most effective for each type of candidate. More specifically, AI associates the proper presentation method (for example, ad, text, and email) with the most excellent candidates. The artificial intelligence system releases job opportunities through pop-up ads, emails, banners, texts, etc. to get the best uptake and response from candidate profiles (Black and Esch 2020b, a). These are the tools to attract potential job seekers successfully (Jäger 2018).

Artificial intelligence can be used for the presentation of job opportunities and precise job descriptions. Adjusting the ad wording and tracking the impact of these changes on the number of applications and applicants may help companies improve the effectiveness of their promotions. Additionally, AI can decide which aspects of a company, such as culture and accomplishments, should be showed to candidates to cause the most positive feedback.

Artificial intelligence can assist companies to increase the pool of applicants and target more suitable ones. In 2017, Loreal used artificial intelligence to present job chances to active candidates and identify passive ones. As a result, it gained 2 million applications for 5000 positions (Black and van Esch 2020b, a). The increased number of applications gives companies more options.

Many companies already have a pool of rejected candidates from the past (Kakatkar et al. 2020). While the fact that these rejected candidates are not a fit for previous jobs can not imply a mismatch with current positions. However, since this past candidate information is out of different information platforms, such as in local servers or third-party digital storage, the manual testing database would be too costly. Artificial intelligence tools can filter past candidates and match them with current positions (Black and Esch 2020b, a).

3.2 Job Search

Traditional job search websites are dependent on the entry of search terms. Artificial intelligence refines the search outcome on a wider and more refined foundation. Candidates may upload their resumes. The educational and professional qualifications required for the position are related to the candidate's maturity, qualifications and occupation, and location (Jäger 2018).

In addition, job seekers who are interested in certain company positions can ask about it through the functional chatbot. This model makes it very interesting for job seekers when an intelligent chatbot is similar to digital assistants that can provide help to job seekers.

3.3 Job applications

Sophisticated AI parsing techniques adopt artificial neural networks and deep learning methods for text understanding (Petry 2018).

Applicants upload their CVs, profile information is analyzed, and AI identifies which information must be transferred to which pre-structured data fields (Strohmeier and Piazza 2015). This technology reduces the workload of applicants and recruiters. A further approach is to fill out complex application forms through intelligent helper without the need for applicants to write and upload CVs (Verhoeven 2020). This method allows all application data to be made available online, and AI collects and sends data to the company's applicant management system.

3.4 Screening and filtering out some candidates

Automatic screening of resumes provides important support during the screening phase, as it reduces the number of errors that can occur when thousands of resumes are manually screened (Abou Hamdan 2019). The AI tools available to us are the “Resume Scorer” or “Optical Character Recognition” (OCR) (Laurim et al. 2021). A “Resume Scorer” is a tool that checks the skills or experience required for a particular job and matches it with the applicant's resume to screen out candidates who do not meet the requirements (Leong 2018). Artificial intelligence comes with OCR to search for keywords and match the applicant's qualifications and job requirements (Dickson et al. 2010). It may be used to check parameters such as a candidate's skills, or salary expectations.

Software controlled by artificial intelligence can identify hard skills and job-related soft ones and candidate personality characteristics. For example, companies can ask candidates to send in a video of themselves as part of the job application. The software analyzes a short video, explores

the personality trait, and forms the analysis result (Escalante et al. 2017).

Finally, the analysis results are compared with the competencies required for the recruitment, the organization's values (Gupta et al. 2018), and the expected package, which leads to a better match between the candidate and the organization. When an individual's abilities, knowledge, and skills are aligned with the job requirements (P-J fit), they should perform better, are more possible to accept a job, and can continue to stay with the organization (Kristof-Brown 2010). Therefore, AI can enable companies to improve P-O and P-J fit.

Studies have shown AI tools outperform humans in screening applicants by at least 25% (Kuncel et al. 2014). For example, L'Oréal used an AI screening tool to reduce the time to review resumes from 40 to 4 min (Black & van Esch 2020b, a). For some companies, reducing the time to hire key talent can gain a competitive advantage. The ability of artificial intelligence to decrease recruiting time represents an efficiency boost and is an advantage in the battle for talent.

3.5 Post-screening assessment

After a company has filtered out some candidates through screening, artificial intelligence evaluation may further narrow the pool. The evaluation may take many forms.

Some are related to gamification tests provide a valuable understanding of skills, abilities, and traits. The evaluation game is implemented in the recruitment process to respond to the relationship between the performance of candidates in the game's success and in certain positions (Bersin and Chamorro-Premuzic 2019). Candidates who meet the job matching requirements in the game test can be scheduled for a final interview.

Using a chatbot, artificial intelligence can support cognitive engagement by interactively asking candidate questions (Sharma 2018). The AI system then analyzes and compares the content of the candidate's answers with those of the top-performing employees. AI also analyzes the vocabulary and sentence structure used in the answers and combines this with content analysis to create a total score for the candidate. The company can conduct final interviews with satisfied candidates and make a final selection decision.

Video-recorded interviews analyzed by AI technology. When interviewing with the candidate, the AI-enabled system asked candidates some questions and they handed in the recorded responses. These questions come from the analysis of these past successful employees and the average employee. Based on this research, AI could analyze which competencies and traits were most possible to lead to success. AI analyzes the responses content, their wording, voice tone (e.g., being enthusiastic about the question), and facial

movements (e.g., frowning when talking about previous jobs) (Black and van Esch 2020b, a), and correlated them with the responses of successful employees. The candidates may join in virtual interviews over a period of several days, on any day, or at any convenient time. Studies consistently show that the candidate has more positive arguments toward experiences where they can have much control over the recruitment procedure (Hamilton and Davison 2018). The AI-supported interview and assessments narrowed down the finalists.

3.6 Coordination throughout the recruitment stage

While AI-enabled recruitment outreach can generate a large number of applications, not everyone will end up getting hired. Companies need to ensure that all candidates, especially those who have been rejected, have a positive experience. Candidates, having had a positive experience when rejected, are more likely to remain open to other opportunities offered by the company (Swider et al. 2015). In addition, the rejected candidate's positive or negative attitudes can affect those around them, such as family and friends (Van Esch et al. 2014). If they have a very positive experience, they are still may recommend people they know to the company. Therefore, companies should construct a positive experience for candidates so that the rejected ones can promote positive word-of-mouth.

For candidates who have been hired or rejected, the AI-supported system will make job applications smoother. With AI's help, candidates do not have to fill out or hand in their resumes. By simply asking applicants to submit their profile, such as from LinkedIn, the AI system will intelligently sort through the candidate's profile and fill out the application for them (Black and van Esch 2020b, a). Once the candidate submits their application, the AI chatbot can answer the candidate's questions about the company, salary, career development, etc. In addition, it can also query the candidate for missing information in their application profile.

Overall, an AI-enabled system may help companies expand their applicant amount, attract the right applicants, reach out to passive candidates, and increase the efficiency of the recruitment process.

4 Research methodology

The objective of this study is to analyze the impact of AI on various participants in the overall recruitment process. These participants include recruiters, managers, and applicants.

Data acquisition. Three target groups, including three recruiters, two managers, and ten applicants, were consulted about their perceptions of the AI recruitment

process. Information about the respondents is presented in Table 2. 15 interviews were conducted in total.

Respondents' profile

1. Recruiters: 3 people are responsible for the overall recruitment of the company. They are responsible for the whole process from recruitment advertisement promotion, applicant tracking, screening, and evaluation.
2. Managers: 2 people from other departments and senior management. They are involved in the entire AI recruitment process and evaluate candidates that are relevant to their business based on their work experience.
3. Applicants: 10 people, apply for different positions and come from different age groups. We can track candidates' experiences and feelings about AI recruitment.

We adopted such a survey method as semi-structured interviews to ensure that participants could have enough discretion to express their whole experience toward AI recruitment and their expectations. The interview questions were as follows:

1. First, each stakeholder was consulted about their experiences, feelings, and attitudes toward AI recruitment in general.

2. Secondly, we set up the recruitment virtual scenario. After that, we invited them to conduct separate AI application scenarios during recruitment. Participants were asked how they felt about the application and recruitment process. The participants were asked about what requirements to meet for them to use AI tools; whether AI brought satisfactory services during their use; whether there was a recruitment function that could not be met; and what improvements needed to be made that could improve the AI recruitment function.
3. Finally, we consulted managers, recruiters, and applicants about their suggestions and future expectations of AI as a recruiting assistant.

5 Stakeholder acceptance criteria

In general, three groups of respondents agreed that AI is more useful for recruitment and job applications. In what follows, we explain the acceptance criteria for each recruitment stage by three groups. Table 3 describes the links between each stage of the recruitment process and the interviewees.

Job advertisement. The criterion used in this phase was the accuracy of the job description. The AI-enabled system in the making of job ads received a positive response from recruiters. This study indicates that recruiters' motivation

Table 2 Respondents' information

Respondent	Basic information	Personal Information
Applicant	21–45 years old; 5 females, 5 males; 0–15 years of experience	3 Interns; 2 Sales Assistants; 2 Quality Engineer; 1 Finance Supervisor; 1 Assistant General Manager; 1 Sales Supervisor
Recruiter	25–35 years old; 2 females; 1 male; 3–8 years of experience	2 Recruiters; 1 Senior Recruiter
Manager	30–50 years old; 2 males; 8–22 years of experience	1 Vice President; 1 Sales Director

Table 3 Acceptance criteria in the recruitment process

Participants			
Recruitment stage	Applicant	Recruiter	Manager
Job advertisement		The accuracy of the job description	
Job search	Convenience and efficiency were used as criteria for this stage		
Application Selection	Application information was accurately parsed and conveyed		
		AI can accurately screen the desired talent instead of mistakenly discarding the potential talent	
Assessment			The crucial aspect of this step is the fairness and impartiality of the AI-guided assessment as well as the trust-building
Coordination	The applicant can be treated as a real client and not just a user	The accuracy of AI-based vacancy prediction	

to adopt AI in daily operation is strongly influenced by AI's ability to enhance recruiters' job performance. Three recruiters were receptive to integrating AI-based software into their daily recruitment efforts. Recruiters found it difficult to design the job ads, mainly in terms of the description of the position elements, such as job content, duties, and requirements. Moreover, the recruiters are not necessarily proficient at writing job ads. AI can analyze and design the job advertisement text in multiple languages and meet the requirements of different positions, which is difficult for ordinary recruiters to accomplish.

Job search. Convenience and efficiency were used as criteria for this stage. Several applicants used the chatbot and found its functionality to be positively evaluated. All applicants agreed that the chatbot was very interesting in finding job opportunities and that they were willing to attempt the feature. However, they also suggested that questions should be answered accurately by AI and that chatbots should ask questions that are more specific to job-related competencies and skills. This phase of the recruitment process also showed that chatbots can support candidates in many ways, but the applicant's intention to use them depends on the convenience and efficiency of AI's use. If applicants realize that AI can interact with them well and does not miss the necessary information, then to some extent, it is adapted to that stage of the job. According to the applicant, it takes time to accommodate the adoption of a chatbot, and of course, we have to fully trust the support provided by AI to build a trusting relationship between humans and machines.

Application. Accurate data transfer to ensure that no talent information is missing is considered the criteria for this stage. Applicants can fill out and upload resumes, but a more advanced approach is for AI to assist in filling out complex application forms. Complex parsing techniques use deep learning and artificial neural networks ways to understand resume information (Petry 2018). After filling out the resume, the resume parser automatically transmits the data to the applicant tracking system. In the tracking system, there are pre-constructed data domains (Strohmeier and Piazza 2015). The parser identifies which components must be transferred to which data domains based on typical text modules. Applicants were surprised to witness that AI could automatically recognize the resumes they provided and even, in some instances, individuals' profiles linked from social networking platforms. Applicants found AI assistance in filling out resumes to be speedy but were concerned that important application information would be lost in the data transmission. After several applicants filled out the job application form, the recruiter proceeded with the recruitment system tracking to compare whether the application information was accurately parsed and conveyed. AI's resume parsing results satisfied the recruiter.

Selection. This stage reflects the key is whether AI can accurately screen the desired talent instead of mistakenly discarding the potential talent. The algorithm of AI should be based on the principle of scientific empirical evaluation. AI builds a model for HR to screen resumes by analyzing the recruitment behavior of a large number of recruiters. In addition, AI combines current users' recruiting needs, company profiles, and candidate preferences to quickly screen a large number of resumes (İşgüzar and Ayden 2019). For recruiters to build trust in artificial intelligence, they will test artificial intelligence reliability by comparing AI decisions with recruiter decisions. AI reliability will make recruiters more confident in AI algorithms and they will choose to utilize them. AI plays an even more prominent role when there are many applicants, helping recruiters reject the unsuitable ones. AI not only screens out the right candidates for a job position but also identifies potential talent that is well suited to it. Applicants who are not suitable for the position currently applied for may be suitable for other positions in the company.

Assessment. The crucial aspect of this step is the fairness and impartiality of the AI-guided assessment as well as the trust-building. Video interviewing is based on the analysis of gestures, the tone of voice, and micro-expressions in conjunction with video capture to complete the interview process (Merlin and Jayam 2018). Thus, it allows a holistic approach to exploring the suitability of the candidate for the job qualifications (Merlin and Jayam 2018). But there are some interpersonal relationships which artificial intelligence cannot perceive in the video. Moreover, recruiters are also concerned about the analysis criteria of video interviews with the help of artificial intelligence. Recruiters also believe that some candidates are not very adept at online gaming. Sometimes the lower scores were not due to their weaknesses in certain skills, but rather a lack of understanding of how to use the game's features. Recruiters and managers also had concerns that some candidates had mastered AI questioning and had consciously avoided certain question traps to achieve high scores. Managers expressed low trust in AI, based on their limited experience with AI. One manager said he would rather spend time looking at a resume than accept the analysis provided by AI.

Coordination. AI systems can automatically schedule calls, tests, and interviews (Kulkarni et al. 2019). This process reflects the principle of whether the applicant can be treated as a real client and not just a user. Applicants overall responded to a more positive feeling and hope to recommend people. However, applicants also mentioned that when communicating with the chatbot, it did not feel as natural as communicating with a genuine human, and the communication was rather stiff, like chatting with a machine. Therefore, the AI system needs to strengthen its algorithms and continuously optimize its communication. Vacancy prediction

software may estimate the likelihood of employees leaving the company by interpreting their behavioral data. It creates job vacancy alerts and alerts recruiters when to advertise a job (Klucin 2020). However, recruiters are concerned about the accuracy of AI-based vacancy prediction, and they suggest that the algorithmic capabilities of AI tools need to be continuously optimized.

6 Stakeholder suggestions

Candidates believe that AI recruitment tools do offer certain benefits, for example, increased interactive experience and faster application process. Recruiters and managers realized the potential of AI recruitment such as faster recruiting, high-quality hiring, decreasing workload, and reducing discrimination. However, participants also highlighted the importance of the criteria in each stage of the recruitment process, otherwise, companies would be afraid of not being able to recruit effectively through the AI system.

Recruiters and managers suggested that AI decisions need match human hypothetical decisions. They believed that it is easier to trust the artificial intelligence tool if it is testable and assessable based on previous successful hiring experiences within the company. Also, recruiters and managers emphasized why AI systems decide whether an applicant is rejected or selected, which would provide more judgment and thus improve the chances of successfully using the AI tool.

Furthermore, recruiters and managers indicated that the ranking of candidate scores provided by the AI system should not be a final decision to give people a sense of more control over the AI hiring process. The controllability also helps people adopt the AI tool. AI developers should provide a basis for corrective action to review and modify AI's inappropriate decisions and provide a fair judgment for future AI-enabled recruitment.

Applicants should understand the benefits of AI tools before applying for a job, otherwise, applicants will not have a strong desire to interact through technology such as chatbots. Furthermore, refinement of AI recruitment functions, as well as the transparency of how the system works, would be important factors in successful AI using by applicants.

Based on this survey, we propose the need for AI governance. For example, AI must learn only what it is supposed to learn to reduce the possibility that AI may be imbued with bias; people need mechanisms to increase flexibility and control over the whole recruitment process. To avoid bias in the AI decision-making process, we make the following recommendations: the ranking of candidates provided by the artificial intelligence system is not the final decision to avoid bias in the decision-making system; humans, not machines, have the final decision on candidates; empirical

evaluation and comparison with past recruitment data should be conducted before implementing AI recruitment; periodic training on machine learning improves the accuracy of the system (Gupta et al. 2018).

7 Implications for management

7.1 The cost of AI recruitment

AI recruiting systems in the 3.0 era are new and challenging. Attempting to implement the system at all levels of employees from the start can increase the cost burden. According to a survey, 68% of HR professionals agree that the main reason they have not implemented an AI recruitment system is that they do not have enough budget to invest (Solascasas Morales 2020). IBM's research team of 6000 people, which included senior HR managers, CEO, and employees, highlighted the fact that the majority of people believe that AI is needed, but they are not ready for the structural transformation (Eric et al. 2017).

Some AI tool use can bring excessive costs. For example, candidates play the game for fun and may not take it seriously, and the score will not be a fully accurate predictor for their job performance, so recruitment costs will increase (Bersin and Chamorro-Premuzic 2019). We suggest that companies with ideas for large-scale implementations of AI recruitment systems should be cautious, as numerous studies have found that 60–80% of large organizational changes, such as digital transformation, suffer setbacks (Black & Gregersen 2013). Thus, companies may economically and effectively apply AI recruiting tools in phases that will create low to medium job or large staffing needs.

7.2 AI-enabled recruitment bias

Although AI can help in decision-making, the datasets and algorithms that guide AI may be influenced by human biases. Human decision-makers sometimes make intuitive decisions based on “a set of tacit preferences” (Shrestha et al. 2019). Research on artificial intelligence decision-making suggests that bias is one of the challenges in developing artificial intelligence (Kaplan and Haenlein 2020; Martin 2019).

AI-driven Job advertisements automatically have some indirect discrimination (Dalenberg and review 2018). Artificial intelligence needs to provide employers with the ability to adjust advertisements according to factors, such as age, gender, language, education, experience, and relationship status. Therefore, these factors determine whether AI-driven job advertisement activities are discriminatory or not. Discriminatory advertisements reduce the opportunities of job seekers with workplace diversity and violate the principle of equality to some extent (Abou Hamdan 2019). Companies

should provide transparency about the algorithm development process, and the training of program developers to prevent unconscious bias (Miller et al. 2018).

Artificial intelligence does not know what bias is or whether it is learning bias (Black and van Esch 2020b, a). In the process of machine learning (ML) conducted by AI, HR practitioners, or managers, inappropriate assumptions can lead to biased decisions. For example, a manager's past decisions may lead to anchoring bias (Edwards and Rodriguez 2019). Especially when developers design artificial intelligence tools by observing present high-performing employees for identifying core competencies and personalities of potential candidates (Neubert and Montañez 2020). If some biases like gender, education, race, and age existed in the past and they are present in the high performers that the company currently uses as benchmarks, the algorithm would learn these conventions and perpetuate the biases (Lee and Shin 2020). It was recently reported that Amazon's AI hiring tool showed bias against women (Fernandez 2019).

Artificial intelligence systems are created, directed, and trained by humans. AI developers need to code algorithms to be neutral concerning gender, race, color, religion, and ethnicity. With the potential for unconscious bias in the past, it is required to deliberately neutralize these biases by freeing AI to learn and emphasize new models and algorithmic inputs to ensure that AI recruitment tools are aligned with HR strategies (Weinstein 2012). As AI faces increasing discrimination challenges, companies should lead through non-discrimination laws to ensure that the target group meets the job requirements.

7.3 Data privacy issues under the law

To develop artificial intelligence for recruitment decisions, a large amount of data need to be collected from numerous sources. These data can come from internal or external sources, or both (Akerkar 2019). The use of external datasets may pose some legal privacy challenges (Chichester Jr and Giffen 2019). Extracting additional information can also lead to legal, ethical, and privacy issues (Akerkar 2019). We recommend AI system developers should be aware of the legal requirements in data acquisition and avoid violating the related law.

However, as soon as laws are passed or people begin to dramatically limit their data on media, this may seriously influence the efficiency of AI outreach tools.

7.4 Threat or support for HR recruitment positions

There is a discussion about whether AI would pose a barrier or threat to the current recruiter's job (Hogg 2019). HR professionals may consider the artificial intelligence recruitment system as a threat to recruiters' jobs and, therefore, they may

not actively pursue AI recruitment tool applications. AI tools are integrated with the recruitment process to support human recruiters in the selection of applicants without replacing the role of humans.

Artificial intelligence systems are a relief for less valuable tasks. Time-consuming administrative duties, such as sourcing and screening candidates, will be delegated to AI technology. It can also be a means of releasing HR departments for higher-value tasks, such as strategic HR matters, supply and demand planning, or specialized sourcing of top talent (Bhalgat 2019; Black and van Esch 2020b, a).

The support of AI tools allows HR employees will be able to invest more time in thinking, creativity, and interpersonal relationships (Ahmed and Reviews 2018; George and Thomas 2019). Language bias and cultural understanding are challenges for AI. AI cannot have human abilities, such as persuasion, building relationships with candidates, and convincing them to stay with you (Guenole and Feinzig 2018). Artificial intelligence is proficient at identifying talent, but activities such as assessing cultural fit still require humans to do so (Soleimani et al. 2021; Upadhyay and Khandelwal 2018). It cannot understand cultural barriers and interact with another person better than humans can do (Nawaz 2019).

Therefore, there are misconceptions about AI replacing the human workforce. Artificial intelligence software and automation take employees out of their workload and allows them to be more strategic and productive.

7.5 Cooperation and competition principles

The concepts of cooperation and competition must be taken into consideration to enable human behavior analysis, manage online dangers, and build effective automated aids (such as artificial intelligence) (Vanderhaegen et al. 2006). While competition corresponds to human unreliability support since each individual seeks to make the others fail, cooperation is perceived as human reliability support since the human operators participating wish to take action successfully.

AI-based recruiting aims to design such AI tools to support quality control of talent selection. The HR work environment in an organization is a shared workplace in which other HR professionals may perceive comparable or dissimilar interactions. In such AI-based recruitment environments, recruiters may undertake actions to facilitate collaborative activities among themselves and others. As stated by Millot and Hoc (1997), two human operators (e.g., two recruiters) are cooperative if each attempts to manage interference to promote his activity and the activity of the other, otherwise, they are competitive.

Further, the design of “cooperative” robots must also be a priority when investigating human–computer interaction

in recruiting from a cognitive standpoint (Sarter et al. 1997). A partially autonomous AI agent can be thought of as a new team member. The development of new coordination requirements comes from treating human and automated agents as cooperative systems. Solutions that build on the principles of human–machine cooperation are provided to keep the human in the recruiting process control loop and to define different levels of involvement based on the level of automation.

7.6 Possible conflicts of shared control

Possible conflicts of shared control exist between humans and autonomous systems. The interaction between AI and humans in different application domains must be extended with state-of-the-art technology.

Vanderhaegen (2021) proposes a heuristic-based, forward-looking approach to identify potential conflicts in shared governance between humans and autonomous systems. This approach uses three elements of Competence-Availability-Possibility-to-act (CAP), which reflects the autonomy features of decision-makers. CAP-based autonomy is decomposed into several control scenarios that are shared within or across workspaces. This heuristic-based approach consists of four main steps: testing shared control, defining detection parameters, identifying potentially conflicting decisions, and testing conflicts. Heuristics are useful for identifying the sources of human–machine conflict. This approach involves a joint management process of human and autonomous systems. The user's awareness of such conflicts is improved through technological learning, improvement of warning systems, and the avoidance of confusion between human and machine intentions.

When a system can manage a process without assistance from people, it is said to be autonomous (Scharre 2015). However, some duties may conflict with or be delegated to humans. Therefore, joint control mechanisms between people and autonomous AI systems must be developed. In accordance with their degree of autonomy, humans and autonomous AI systems are each granted a certain amount of control over a particular process, according to the shared control concept (Vanderhaegen 1999).

Human–AI interface tools that may combine several modalities, such as visual, auditory, tactile, and conversational, are necessary for the potential of such interaction. They serve as instruments for controlling distributional choices made by autonomous systems and people. Depending on the potential evolution of CAP parameters, the CAP-oriented joint control between humans and AI systems may be static or dynamic. Using CAP parameters, a technique is used to find AI application scenarios that divide control duties between people and AI systems.

They can be used in a study on recruiting automation. Humans and autonomous systems may have misunderstandings or be confused, and some disputes may result in adverse circumstances. For example, when a candidate participates in a test conducted by an AI tool through extensive simulation interviewing training or computer applications with testing skills and receives a high score, the AI recommends these to the candidate pool. This behavior is not consistent with the assumptions of the recruiter or the company. Because people expect to recruit really qualified people. At this point, the machine has made an error in judgment; the AI is unfairly evaluating the candidate's based on specific historical data (with some bias or prejudice), such as the AI's belief that the technological field is more suitable for men than women in some company recruiting. In fact, the historical data itself are sourced from technology companies with an imbalance between men and women, which are looking to recruit some women to balance the company's gender ratio.

By identifying potential conflicts in shared control, the CAP-based approach is an effective and cutting-edge way to optimize the design of shared control processes between humans and autonomous systems. There are three techniques to manage task-sharing disputes between people and autonomous systems or to increase the autonomy of the systems: create online learning platforms that will give autonomous systems a greater sense of autonomy and make them more receptive to human habits. For instance, if some job candidates are not accustomed to utilizing an intelligent recruiting interface, this information must be incorporated into an AI-based recruitment system; a sophisticated alert system must also be developed to manage human attention. A chatbot session system based on intelligent interviewing would be appropriate; Users might be made aware of these conflicts using tutorials about the application of AI-based tools for recruitment.

7.7 Limitations of the study and future research

Although AI research results provide important contributions to theory and practice, we acknowledge that the study has certain limitations. The theoretical literature should be explored in more depth, such as the machine learning principles and algorithmic rules for AI recruitment; the data and scope of the quantitative study are not sufficient. The study should be extended to different companies or different countries to increase the number of respondents and the variability.

We can also conduct future studies: group level or executive understanding and the perception of AI recruitment; performance of employees who join through the AI recruitment tool compared to human recruitment; development of operational guidelines and training materials to

guide users in conjunction with AI developers; and comparison of attitudes toward AI recruitment among candidates from different positions and job titles.

8 Conclusion

This study follows an application–criteria–attention approach. It analyzes and develops a paradigm for the application of AI tools in the recruitment process. Criteria for successful AI-based recruitment are also suggested. Managerial focuses on AI-based recruitment have been raised, such as fairness, legal privacy, and cost issues.

In addition, this study presents that identifying the user's cognitive workload is used as a fundamental concern in human–computer recruiting systems. The analysis points out that higher AI support often helps recruiters work less cognitively.

Moreover, the study states that cooperation and competition must be taken into consideration to enable human behavior analysis, manage online dangers, and build effective automated aids.

The study indicates that possible conflicts of shared control exist between humans and autonomous recruiting systems. The interaction between AI and humans in the recruiting process is extended with state-of-the-art technology, which uses three elements of Competence-Availability-Possibility-to-act (CAP). The user's awareness of such conflicts is improved through technological learning, improvement of warning systems, and the avoidance of confusion between human and machine intentions.

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