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DEVELOPMENT OF AN INTEGRATIVE VALIDATION MODEL FOR RECRUITMENT: BALANCING AI EFFICIENCY, PREDICTIVE ANALYTICS AND ETHICAL RESPONSIBILITY

Volker Joachim Römer
University of Library Studies and Information Technologies
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Abstract: *The process of recruitment is experiencing a basic digital transformation, with a shift away from traditional recruitment techniques towards AI-enabled decision-making. While information systems like Applicant Tracking Systems (ATS) and Recommender Systems make the process much more efficient and cost-effective, they create new risks in terms of algorithmic bias and non-transparency. This paper is an attempt to propose an "Integrative Validation Model" that extends the traditional notion of predictive validity. It argues that modern recruitment tools must be validated not only by their ability to predict job performance (efficiency) and that they should also comply with ethical standards (responsibility). The methodology is grounded on a systematic literature review of recent studies between 2015 and 2024. The findings suggest that to be sustainable recruitment success requires incorporating "Responsible AI" principles into the information management process. This approach supports a holistic approach that ensures that organizational goals are aligned with social responsibility.*
Keywords: *recruitment validation; information management; applicant tracking systems; AI ethics; algorithmic bias*

INTRODUCTION

The face of human resource management is undergoing a paradigm shift today, thanks to the explosive developing technologies. As Bhushan (2024) notes, recruitment is no longer a simple, administrative task, but rather a complex and multi-dimensional information management process. In the past, recruitment used to be characterized by manual screening of physical documents and subjective decision-making. Today, it is characterized by "E-Recruitment" which is the use of digital platforms, automated screening tools, and data analytics to recruit and select candidates worldwide.

This "Digital Transformation" is not simply a change of tools, but a change of strategy. Organizations are facing more pressure to shorten the "Time-to-Hire" and reduce the "Cost-per-Hire" while making the candidates of higher quality. Potocnik et al. (2021) point that this pressure has resulted in the widespread use of algorithmic assessment tools. These tools promise to measure applicant knowledge, skills, abilities and other characteristics (KSAOs) with a speed and consistency that human recruiters cannot provide.

However, this need for automatic processing of information generates a crucial tension. While efficiency is being driven up the validity of the underlying decisions is often questioned. Laumer, Maier, and Eckhardt (2015), however, argue that despite the benefits Business Process Management (BPM) systems have in streamlining flow processes, in no way do they guarantee the quality of the hiring decision. Furthermore, there are new risks posed by the introduction of Artificial Intelligence (AI). Mask and Pearl (2024) warn of the data bias of AI systems which are frequently trained on past data that contain the biases of human decisions. If an algorithm learns from a history in which certain demographics were systematically disadvantaged, then it will be automated and enforced.

Consequently, traditional models of validation, in which the emphasis has been on "predictive validity" (the statistical correlation between a test score and job performance), are no longer adequate. A statistically predictive, but unethical recruitment process is a severe legal and reputational risk to the organization.

This paper addresses this gap by proposing an Integrative Validation Model. This model proposes that validity in the digital age needs to be three-dimensional in nature: that it must include Technical Efficiency (speed and cost), Predictive Accuracy (quality of hire), and Ethical Responsibility (fairness and transparency). Through a synthesis of the latest literature, the project aims to offer a framework for the validation of recruitment procedures that meet both the economic needs of the business and the ethical standards of society (Bujold et al. 2024).

RESEARCH METHODOLOGY

This publication uses qualitative research methodology based on systematic literature review. The goal was to examine the intersection of information systems, recruitment analytics, and business ethics to obtain an overall validation framework.

Data Collection and Data Selection

The review focuses on academic papers, specialist books, and systematic reviews published from the period 2015 to 2024 mainly. This timeframe has been chosen in a way that it encompasses the latest developments in the world of technologies like the coming of Generative AI, state-of-the-art Recommender Systems, etc. The selection process was done in a organized manner looking for important sources dealing with 3 basic themes:

1. Information Systems in HR: Studies analyzing the impact of ATS and BPM on process performance (e.g. Laumer et al. 2015).

2. Algorithmic Decision-Making: Technical papers of the the functioning of recommender systems and AI algorithms function in a recruitment context (e.g., Freire & De Castro 2021).

3. Ethics and Bias: Review of algorithmic discrimination & responsibility of AI frameworks (e.g. Kochling and Wehner 2020; Hunkenschroer and Luetge 2022).

Data Analysis

The selected literature has been analyzed based on the thematic synthesis approach. Instead of a statistical meta-analysis, the study is concerned with the extraction of conceptual frameworks and empirical findings with the goal of constructing the Integrative Validation Model. Special attention was paid to "Review of Reviews" (e.g., Potocnik et al. 2021) to ensure a broad coverage of current state of research without having to rely on single, potentially isolated case studies.

THEORETICAL FRAMEWORK

In order to gain an understanding of the need for an integrative validation model, it is important to first examine the underlying technological infrastructure, as well as the theoretical development of recruitment from a manual task to a data-driven science.

Information Systems Used in Recruitment

The backbone of modern recruitment is constituted by sophisticated information systems to manage the flow of data of candidates. Laumer, Maier and Eckhardt (2015) describe Applicant Tracking Systems (ATS) not as simple databases but as full-fledged Business Process Management (BPM) tools. These systems standardize the entire lifecycle of recruitment - from job posting to onboarding. From an information science point of view, an ATS is like a central storage which guarantees data consistency and allows process automation. The primary theoretical argument for their adoption is the reduction of "media disruptions" which occur when data is manually travelled between systems (e.g. email to spreadsheet) and are therefore prone to error and inefficiency.

Furthermore Freire and De Castro (2021) point on the rise of Recommender Systems (RS) in these platforms. Borrowing from technologies developed in e-commerce, the recommenders for e-recruitment use two primary filtering techniques to validate candidates:

- Content-Based Filtering: In this method, the semantic content of a CV (keywords, skills, experience) is analyzed, and it is matched with the job description. It assumes that the higher the overlap of keywords, the higher the validity given to the candidate for the role.
- Collaborative Filtering: This is a more complicated method that predicts the suitability of a candidate based on the behavior of other similar people or past hiring patterns. If Candidate A has a similar profile to successful Employee B, the system deduces a high probability of success.

Talent Intelligence Predictive Analytics

The conceptual shift from operational to strategic decision making is conceptualized as "Talent Intelligence". Rutten & Verhoeven (2024) propose a model of maturity of recruitment analytics that organizations need to go through in order to obtain valid results:

- Descriptive Analytics: The first level, concerned with what happened (e.g. "We received 500 applications"). While necessary for reporting, this does not provide any validation of quality.
- Diagnostic Analytics: Deals with why it happened (e.g. "Why did the hire rate drop?").
- Predictive Analytics: The critical stage for validation. Here, the historical data is used to predict what will happen in the future (e.g. "Candidates with this skill set have a 90% retention probability").
- Prescriptive Analytics: This is the highest level where the system makes specific recommendations (e.g. "Interview this candidate immediately to prevent drop off").

For an integrative validation model, the shift to predictive and prescriptive analytics is important. However, Rutten and Verhoeven (2024) claim that validity of these predictions is without separation linked to data quality. Inconsistent data entry or unstructured feedback in the ATS causes "noisy" data which makes predictive models invalid.

The Idea of the Algorithmic Validity

Traditionally, validity in recruitment was described through psychometric criteria – mainly "criterion-related validity", which is a measure of the correlation between a test score and job performance (Potocnik et al. 2021). In this era of AI, this definition needs to be extended to include Algorithmic Validity.

Kochling and Wehner (2020) say that an algorithm is only valid if it is free from systematic bias. Unlike individual and sporadic human bias algorithmic bias is systematic and scalable. If a machine learning model is trained on a dataset where a certain demographic was historically at a disadvantage (say, women not being hired for tech positions in the past) the algorithm will look for this as a "valid" predictor of unsuitability. Therefore, in the context of information management validity must include not only the statistical accuracy of the prediction (does it predict the outcome?), but the ethical integrity of the data processing (is the prediction based on merit or bias?).

RESULTS

The systematic analysis of the selected literature reveals three main dimensions influencing the validity of modern recruitment procedures, namely Process Efficiency through Information Systems, the steering function of Data Analytics and a critical challenge of Algorithmic Bias.

1. Efficiency through Information Systems and Standardization

The empirical evidence validates that the integration of Information Technology (IT) and Business Process Management (BPM) does not only mean the digitization but the fundamental restructuring of recruitment. Laumer, Maier, and Eckhardt (2015) in a quantitative study of leading companies showed that the use of Applicant Tracking Systems (ATS) and rigorous process analysis beats cycle times and process costs to a huge degree. Their findings show that efficiency gains are not gained through software but through the standardization of the work flows that the software imposes.

This minimizes disruptions to the media and maintains consistency of data. Furthermore, Freire and De Castro (2021) identify Recommender Systems as an important technological solution to cope with the "information overload" in e-recruitment. By using content-based and collaborative filtering techniques, these systems can filter through thousands of profiles in no time. This automation enables recruiters to concentrate on the best possible candidates and therefore makes matching candidates to job openings much faster and accurate.

2. The Steering Function of Recruiting Analytics

Modern recruitment is no longer viewed as a reactive administrative process but as a strategic, data-driven operation, and is sometimes referred to as "Recruiting Analytics" or "Talent Intelligence". Rutten and Verhoeven (2024) suggest that, in order for recruitment to be valid, there is a need to move "beyond simple descriptive reporting (e.g. how many applicants?)" towards

predictive analytics (e.g. who will likely succeed? They point out that Key Performance Indicators (KPIs) like "Time-to-Hire", "Cost-per-Hire" and "Quality-of-Hire" must be monitored in real-time to drive the talent acquisition strategy effectively.

However, the validity of these analytics has a strict dependence on the quality of the underlying data. If the input data is inconsistent or incomplete the predictive models will give invalid results. Therefore, data management must have strong data governance for analytics to be a reliable tool for decision making.

3. Algorithmic Bias and the "Amazon Case Study"

A great and important finding, included into the recent literature, is the prevalence of the biasness in the case of algorithmic decision making, which contributes to the loss of validity of the recruitment procedures. Mask and Pearl (2024) argue that although AI tools are efficient, they tend to suffer for lack of transparency – it is a "black box". This circumstance makes it hard to validate whether a decision was made on merit or whether it was based on spurious correlations.

This theoretical risk is supported by hard empirical evidence. Kochling and Wehner (2020) have a detailed analysis of the prominent Amazon case study. In this case, an experimental hiring algorithm developed by Amazon taught itself to penalize resumes that contained the word "women's" (e.g. "women's chess club"). This error occurred not because the algorithm was programmed in a sexist way, but because it was trained on 10 years of historic hiring data, which was dominated by male resumes.

The system was statistically validating the correlation between "being male" and "being hired" in the past and projecting it into the future. This case is a vivid example of the peril in relying only on predictive validity: The system was statistically correct in its ability to reproduce the patterns of the past, but invalid from an ethical and legal standpoint. Consequently, it is suggested in the literature that technical validation of information systems must always be accompanied by ethical auditing in order to detect such "historical biases" before they are automatized.

CONCLUSIONS AND DISCUSSION

This study proposes Integrative Validation Model of recruitment. This model assumes that recruitment procedure can only be "valid" if it meets three criteria at once: efficient (IT-backed), predictive (Data-driven) and ethical (Bias-free). The result of the analysis is that when only one aspect is focused on, it is doomed: Efficiency without ethics is discrimination; ethics without efficiency is competitive disadvantage.

Integration of Responsible Basic Artificial Intelligence Settings

The results indicate that companies simply cannot stop with technical validation. Bujold et al. (2024) suggest the implementation of "Responsible AI" principles in Human Resource Management. This suggests that validation is not a once in a lifecycle event but rather a continuous process.

- Transparency: Organizations need to be able to explain how their algorithms work. "Black Box" systems must be avoided when it comes to high-stakes decisions such as hiring;
- Human Oversight: As suggested by Hunkenschroer and Luetge (2022), it is always a good idea to ensure that the final decision of hiring someone is always left up to a human ("Human-in-the-loop"). The AI is supportive in delivering information but not the final word.

Implementation Strategy: The Need for Parallel Testing

Given the identified risks of algorithmic bias and error, organizations should be extremely careful when ascribing new AI tools. It is strongly recommended that human decision-making is not replaced suddenly. Instead a parallel implementation strategy (or "Shadow Mode") should be adopted.

In this phase, the AI system is used in concert with traditional processes for evaluating a system, but it does not make final decisions. For example, recruiters use manual CV screening and the AI runs in the background. After a set period of time, the results are compared: Did the AI reject highly rated candidates as rated by humans?

Were demographics shown to be biased by this AI? Only in case the AI can prove valid and

unbiased results over a defined time of testing, it should be incorporated into the active workflow. This is to ensure that the information management system is not validated in an artificial environment before affecting real-world hiring decisions.

Future Challenges The work results of AI generated output

Looking forward, the rise of Generative AI (e.g. ChatGPT) brings new issues to information management. Hagendorff (2024) charts the ethics of these powerful models and draws attention to the risks of such models, including the danger of them hallucinating (inventing facts) and producing harmful or false content.

For recruitment and this means new validation risks. If candidates use AI to polish their CVs, and companies use AI to screen them, the whole process may become detached from reality. Furthermore, if Generative AI is used to write job descriptions, it could potentially use biased language. Therefore, validation models must move to the dynamic. Organizations need to constantly audit not only the result (who is hired) but the process of generating information itself.

Implications for Practice

The shift to an integrative validation model has huge practical implications for human resource professionals and organizational leaders. This research proves that having an Applicant Tracking System (ATS) or an AI-based screening tool in place is not enough to guarantee valid recruitment results. Instead, these technologies need active, ethical and ongoing management in order to avoid automating bias, and ensure compliance with the law.

1. Algorithmic Auditing Protocols

Organizations have to change their basic thought process fundamentally from a passive approach to distrusting technology to an active approach of verifying the technology. As suggested by Hunkenschroer and Luetge (2022), it is imperative for companies to introduce a formal "Algorithmic Auditing" process as an integral and permanent part of their information management strategy.

In practice, this is a stringent approach that requires a comprehensive evaluation strategy commencing long before the technology is in active use. Therefore, a critical "Pre-Deployment Audit" is needed whereby new AI tools need to be rigorously tested for "disparate impact" on the basis of historical data sets before being integrated into the live recruitment workflow.

During this phase, HR managers are responsible for checking whether the tool's recommendations are consistent with organizational objectives for diversity, or whether the system in some way systematically discriminates against certain demographic groups – e.g. by unfairly penalizing gaps in CVs that may correlate with parental leave.

However, validation suggests more than a one-time approval - it should be considered as a continuous and dynamic process which is known as "Post-Deployment Monitoring". This constant watch is necessary because predictive models are prone to "concept drift," a phenomenon in which the accuracy of the predictive model may degrade with time as the job market and applicant behaviors change. To fight this loss of validity is necessary regular spot-checks, in which human recruiters manually read through applications that were rejected by the AI. Detecting these "False Negatives" is critical to ensure that the system is valid, fair and accurate over the long term.

2. Improving the skills gap: Data competence in HR

As Potocnik, et al. (2021) conclude, the field needs more sophisticated psychological and technological theories. For practitioners, this suggests a needed change in competencies. Rutten and Verhoeven (2024) point out that modern recruiters need to have a high level of "Data Literacy". They must be made to understand that the "matching score" of 85% that an AI might generate is not an absolute truth, but a statistical probability based on certain input variables. Training programs must therefore be concerned not only with how to operate the software but how to interpret critically its outputs.

HR professionals need to be given the power to override algorithmic suggestions if their own judgement, informed by their human empathy and contextual understanding, flags up a valid candidate the system missed.

3. Interdisciplinary Collaboration

Finally, to effectively manage information in recruitment, the organizational silos should be broken down. Bujold et al. (2024) highlight that responsible AI is not something that can be accomplished by the HR department alone. It demands an interdisciplinary approach brought together by IT specialists (knowledge of the code), legal experts (knowledge of compliance) and HR psychologists (knowledge of job fit).

Only by this collaborative effort can the organizations achieve the right balance between the efficiency gains of digital transformation (Bhushan 2024) while still adhering to strict ethical standards in order to keep a "social license to operate." Companies who are successful in this balancing act will have achieved true validity in their recruitment procedures - which is fast, cost effective, and fundamentally fair

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РАЗРАБОТВАНЕ НА ИНТЕГРИРАН МОДЕЛ ЗА ВАЛИДИРАНЕ ПРИ ПОДБОРА НА ПЕРСОНАЛ: БАЛАНСИРАНЕ НА ЕФЕКТИВНОСТТА НА ИЗКУСТВЕНИЯ ИНТЕЛЕКТ, ПРОГНОЗНИЯ АНАЛИЗ И ЕТИЧНАТА ОТГОВОРНОСТ

Резюме: *Процесът на подбор на персонал претърпява основна цифрова трансформация, като се наблюдава преход от традиционните техники за подбор на персонал към вземане на решения с помощта на изкуствения интелект. Макар информационните системи като системите за проследяване на кандидати (ATS) и системите за препоръки да правят процеса много по-ефективен и рентабилен, те създават нови рискове по отношение на алгоритмичната пристрастност и липсата на прозрачност. Настоящата статия е опит да се предложи „интегративен валидационен модел", който разширява традиционното понятие за предсказуема валидност. В нея се твърди, че съвременните инструменти за подбор на персонал трябва да бъдат валидирани не само по своята способност да предсказват работните резултати (ефективност), но и по това дали отговарят на етичните стандарти (отговорност). Методологията се основава на систематичен преглед на литературата от последните проучвания между 2015 и 2024 г. Резултатите показват, че за да бъде*

успешен, подборът на персонал трябва да включва принципите на „отговорната изкуствена интелигентност“ в процеса на управление на информацията. Този подход подкрепя холистичен подход, който гарантира, че целите на организацията са в съответствие със социалната отговорност.
Ключови думи: *валидиране на подбора на персонал; управление на информацията; системи за проследяване на кандидати; етика на изкуствения интелект; алгоритмична пристрастност*

Фолкер Йоаким Рьомер, докторант
Университет по библиотекознание и информационни технологии
София, България
E-mail: roemer.volker@gmx.de