Leveraging Big Data and AI for Personalized Career Pathways: A Systematic Literature Review

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Big Data and Artificial Intelligence (AI) offer groundbreaking opportunities to create personalized career pathways by leveraging individual profiles, industry trends, and skill requirements. This systematic literature review (SLR) synthesizes research on the application of these technologies in career planning and exploration activities, based on a review of 52 documents published between 2017- 2024 from Scopus database. The findings showcase key areas where AI and Big Data technologies are applied, contemporary trends and latest technological tools. Finally, the study concludes by providing actionable implications for both employers and employees, facilitating the effective adoption of technology at the workplace.

Keywords: Career Planning, Career exploration, Artificial Intelligence, Big Data, Systematic Literature Review

1. Introduction

The rapid advancements in technology has intensified the inherent dynamic nature of the career landscape, requiring individuals to adopt innovative approaches towards career development. As attempts by individuals towards career planning continue to evolve in response to emerging industrial shifts and changing skill requirements (which make traditional career development practices practically less relevant), the role played by technologies like Big Data and Artificial Intelligence (AI) in enhancing these processes has increased manifolds (Nayak et al., 2024). Specifically, these technologies offer the potential to transform career planning by enabling the design of personalized career pathways tailored to individual strengths, aspirations, and market demands (Pandya & Wang, 2024). Current literature indicates that these technologies are supporting a diverse range of populations, including students, emerging adults, job seekers, and early to mid-career employees.

In the context of new job roles and emerging career opportunities, Big Data analytics has emerged as a powerful tool for aggregation, analysis and uncovering patterns from vast, complex information from diverse sources, including resumes, job descriptions, market trends, and performance (e.g., academic performance or career performance), and the job market. When combined with developments in AI technologies like machine learning (Kone et al., 2024), explainable AI (Guleria & Sood, 2022) or genetic algorithms (Yessefi et al., 2024) , these insights can be used to predict promotability and career success, identify competency and skill gaps, build job recommender systems, and provide actionable recommendations and career guidance. AI-driven algorithms, particularly those leveraging machine learning and natural language processing, play a pivotal role in creating predictive and adaptive models that aid in career decision making, thus guiding individuals toward optimal career decisions.

Though still in its nascent stage (Pandya & Wang, 2024), research in this field is growing at a substantial pace. Therefore, this study seizes the opportunity to synthesize existing research and present a comprehensive overview of the developments in this field till this date. In particular, this review addresses the following research questions:

RQ1: What are the dominant themes identified in the literature regarding the application of AI and Big Data technologies in enhancing career planning processes?

RQ2: What are the latest developed models/ tools (e.g., predictive models) (published in peer-reviewed journals) in facilitating career planning?

RQ3: What are the major challenges faced in the implementation of these technologies in the career development arena?

RQ4: What future research directions can be provided in relevance to the identified challenges?

I believe that such a review would be beneficial and whole- heartedly appreciated by many of the stakeholders. For example it can offer career counselors and advisors valuable insights into how AI and Big Data can enhance personalized career guidance and give them the foundational knowledge about integrating advanced technologies into the career services offered by them. For early career researchers, this review will serve as a comprehensive resource to understand the current state of the field and identify research gaps. Researchers can leverage the future directions provided in this study to explore new theoretical frameworks, methodologies, and samples in this rapidly evolving area. For HR managers and organizations, this review offers a roadmap on how AI and Big Data is changing the world of work and they can better their talent acquisition practices, career development programs, and employee retention strategies in response to it. Lastly, for individuals including job- seekers, emerging adults and early to mid- career employees, this review offers insights into emerging trends helping them in making informed decisions pertaining to their adaptability and survival in the changing job market. In

general, the study contributes to the broader understanding of how technology can democratize access to career opportunities by facilitating personalized career paths, and the associated ethical concerns.

The rest of the paper is structured as follows. Section 2 gives an overview of the research methodology followed by results and discussion in Section 3. Finally , section 4 concludes with final notes.

2. Research Design

The research design employed in this study focuses on the identification, screening and analysis of relevant literature to address the key research questions. To ensure such a coherent synthesis, I adopt the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework (Moher et al., 2009), which is a standardized and universally accepted protocol, aimed at improving the quality and transparency and mitigating publication biasness in systematic reviews and meta-analyses (Karaca-Atik et al., 2023). The following subsections outline the processes involved.

2.1 Data Collection
A comprehensive search strategy was employed to gather relevant literature including research articles, conference proceedings, and book chapters. Editorials, erratums, notes and data papers were excluded. The search was conducted across the Scopus database (in the fields of "title", "abstract" and "keywords") in the areas of "Psychology", "Social Sciences" and "Business, Management and Accounting", using the search string:

TITLE-ABS-KEY (("Big Data" OR "Artificial Intelligence" OR "Machine Learning" OR "AI") AND ("Career Planning" OR "Career Exploration" OR "Career Path*" OR "Job Search" OR "Vocational Guidance" OR "Employment Outcomes")) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "PSYC") OR LIMIT-TO (SUBJAREA , "BUSI"))

This first search resulted in 156 documents. As the second search, I explored several prominent journals in the field of career development and vocational guidance that are not indexed in the Scopus database (e.g., Canadian Journal of Career Development). I also included relevant papers found through Google search, beyond the subject areas specified in the Scopus search, resulting in a total of 185 identified documents ready for screening. No duplicates or erroneous entries were found in the final data pool.

2.2 Data Screening – INCLUSION and Exclusion Criteria
In the document screening process, each document was evaluated by examining its title and abstract to determine its relevance for inclusion based on a predefined set of inclusion and exclusion criteria (Table 1). Documents that did not meet the inclusion and exclusion criteria were removed. For instance, only articles published in English were included (*I1*), due to language limitation of the author. Additionally, in order to be able to review a full document, full-text versions of the documents were sought. Consequently, articles for which full-text access was unavailable were excluded from the review (*I3*). The completion of the screening process resulted in a final set of 52 documents, all of which were deemed suitable for further review and analysis in the context of this study.

Table 1 Inclusion/ Exclusion Criteria used for searching relevant literature

I/E No and Criteria		Details
I1	*Language*	: Documents published in English.
I2	*Document type*	: Peer- reviewed research articles, conference proceedings and book chapters.
I3	*Accessibility*	: The document must be available in full- text format.
I4	*Subject area*	: Psychology, Social sciences, Business and Management
I5	*Relevancy*	: Documents focusing on the usage of Big Data and AI in crafting of personalized career pathways. + Documents addressing challenges faced by AI in relation to career development.
Note: I./E No: Inclusion and Exclusion Criteria Number		

3. Findings and Discussion

3.1 Descriptive Summary
The literature review included 52 papers, consisting of 12 conference papers, 33 journal articles, 6 book chapters, and 1 book, spanning 23 academic journals, including prominent journals in the field such as Journal of Vocational Behavior, Career Development International etc.. These papers cover a variety of disciplines, including educational psychology, career counseling, human resource management, organizational and industrial psychology, decision sciences, and hospitality and tourism. Among the most cited papers are "Explainable AI and machine learning: performance evaluation and explainability of classifiers on educational data mining inspired career counseling" (41 citations) published in Education and Information Technologies, "How does smart technology, artificial intelligence, automation, robotics, and algorithms (STAARA) awareness affect hotel employees' career perceptions?" (27 citations) published in Journal of Hospitality Marketing and Management, and "Transparency and Trustworthiness in User Intentions to Follow Career Recommendations from a Learning Analytics Tool" (12 citations) published in Journal of Learning Analytics. Additionally, the book "AI-Oriented Competency Framework for Talent Management in the Digital Economy: Models, Technologies, Applications, and Implementation" has received 26 citations.

3.2 Major themes in Career Pathways using Big Data/ Artificial Intelligence (RQ1)

A thorough and rigorous review of the identified literature highlights the emergence of five major and distinct themes, each reflecting key areas of focus and inquiry within the field. These themes are:

3.2.1 Theme 01: Recommendation and Support Systems for Career Decision- Making

This theme focuses on the job searching behaviors of individuals and the role of AI and its sub- fields like machine learning, natural language processing, and deep learning (Zawacki-Richter et al., 2019) in enhancing the efficiency of the job-searching, job- matching and career decision- making process. Key trends in this theme explore development of job recommender systems (e.g., Dascălu et al., 2023; Deshmukh & Bajaj, 2024) using large scale recommendation and hybrid job recommendations using deep learning (Shalaby et al., 2017) , data mining (Heggo & Abdelbaki, 2018) and learning analytics (Gedrimiene et al., 2023). Apart from job recommenders, this theme also includes AI- based support systems for academic achievement (e.g., Phummapooti et al., 2024; Yessefi et al., 2024). One such example of decision support systems based on genetic algorithms to enhance academic career planning is highlighted by Yessefi et al. (2024). Genetic algorithms can take student's academic information (e.g., learning styles, data about study units or modules, academic talents and competencies, and learning objectives) to refine and adapt existing study pathways and generating alternative academic paths which are more realistic, objective, coherent, and tailored towards students' preferences.

This theme is particularly relevant for both the job-seeking population, who can benefit from more personalized job recommendations, and HRM managers involved in recruitment, who can leverage AI-driven tools to streamline hiring processes. Researchers mainly from technical backgrounds (e.g., Information Technology, Computer Sciences) contribute most significantly towards this theme.

3.2.2 Theme 02: AI for Lifelong Learning and Upskilling

This theme emphasizes the role of Big Data and AI in enhancing technical learning and training, with a particular focus on integrating AI into coaching, mentoring, and apprenticeship programs (e.g., Kong et al., 2024; Reilly & Reeves, 2023). For example, Terblanche & Tau (2024) explores the effects of cost-effective coaching using AI chatbot (i.e., the goal-attainment AI chatbot) to support graduate employees through self- reflection and self-awareness, to reach their career goals in niche organizational contexts. In another study, Wong et al. (2024) analyses machine learning-assisted recommendation systems (MARS) and their ability to improve Generic Competency Development Activities (GCDAs) (i.e., critical thinking, problem-solving, creativity, communication, and social skills) of students.

A key aspect of this theme is its potential to expose individuals to emerging and niche occupations, providing them with opportunities to develop the knowledge, skills, and abilities (KSAs) necessary for career progression (Brougham and Haar 2017; Pathak and Solanki 2021). The theme is particularly relevant for early- and mid-career employees, individuals in career transitions, and HRM managers involved in designing career interventions and training programs. Additionally, the studies in this theme explore organizational contexts, as competency development and upskilling of employees are central activities in Human Resource Development (HRD) programs. The literature also addresses the disruptions in HR practices brought about by the increasing penetration of AI in the work environment, linking it to key HRM concepts and the turbulent landscape of career development (e.g., Tumwebaze Alicon & Kalinaki, 2023; Rachma et al., 2024; Başer et al., 2024).

3.2.3 Theme 03: Modeling Career Paths using Big Data and AI

This theme represents the most prominent and expansive cluster in the reviewed literature, focusing on modeling of individual's career choices and career pathways using AI-driven frameworks. These models utilize diverse data sources to analyze, understand and predict future career pathways. Consequently, technologies like predictive analytics plays a pivotal role in this theme. For example, Haque et al. (2024) employs Synthetic Minority Oversampling Technique (SMOTE), Adaptive Synthetic Sampling (ADASYN) and Automatic Feature Selection Methods (AFSMs) to predict career trajectories. Similarly, Sun et al. (2023) using categorization theory designs explainable AI (XAI) to predict employees' occupational mobility. He & Shen. (2024) predicts career changes and occupational substitution rates using statistical model and Artificial Intelligence-Generated Content (AIGC). Also, researchers in this theme have contributed significantly improvement and refinement of existing AI- driven models by including various contextual factors or by leveraging on different data sources. Exemplars include, predicting career decisions through social media usage (Yang & Chang, 2023); and predicting academic performance from social skills (Espinosa-Pinos et al., 2023). In another study, Guo & Qi (2022) highlights ways to visualize students career paths using Big Data and deep learning algorithm called the LSTM-Canopy algorithm.

A progressive and niche subfield within this theme is the modeling of sustainable careers using AI (Donald et al., 2024; Jang & Kyun, 2022). These studies emphasize the long-term viability of career pathways and the alignment of career choices with evolving labor market demands, skillsets, and personal aspirations.

3.2.4 Theme 04: AI literacy

This theme emphasizes increasing awareness and providing education on how AI and Big Data technologies can be harnessed to create and enhance career opportunities. It primarily focuses on equipping individuals, particularly students, adolescents, and early-career employees, with the knowledge and skills to navigate technology-driven career landscapes. In educational context, Hong & Kim (2024) reports improvements in career self-efficacy and learning flow of students with intellectual disabilities when undergone a AI- based career education program. In organizational context, Zhang & Jin (2023) using

Stimulus-Organism-Response (SOR) framework investigates how being aware about smart technology, artificial intelligence, automation, robotics, and algorithms (STAARA) influences hotel employees' career mobility and job security.

Educational psychology plays a pivotal role in this domain, with studies exploring innovative learning practices and interventions that integrate technology into career education. These interventions not only enhance students' understanding of AI's potential in the workplace but also facilitate smoother school-to-work transitions by preparing individuals for technology-centric careers. Overall, this theme bridges the gap between education and career development, empowering the next generation to leverage AI and Big Data effectively for future career success.

3.2.5   Theme 05: Career Counseling Practices and AI

This theme explores how Big Data and AI can enhance the effectiveness of services provided by career counselors. It is noteworthy that this theme is distinct from Theme 1, as in the later, AI acts somewhat as a virtual career counselor itself. Instead, studies within this theme aim to design AI-driven tools that empower career counselors to increase their capability to support their clients. The focus is on improving existing career counseling practices by leveraging AI as a bridge between a counselor and his/ her clients. By doing so, AI strengthens the counselor-client relationship and ensures that career counseling services remain relevant and effective in an increasingly technology-driven environment. Studies falling in this niche theme include Donald & Straby (2024) which combines combine traditional narrative storytelling approaches with Artificial Intelligence's (AI) to help career development professionals support their clients support their clients to consider various career-related options as well as identify strengths and opportunities for personal development. Similarly, Guleria & Sood (2022) which uses machine learning and Explainable AI (XAI) based approach to capture complex experiences of clients (inputs from students and parents), build inferences and help clients and counselors consequently in taking informed career decisions.

This theme primarily caters to researchers in counseling and vocational guidance practices, offering insights into how counselors can integrate AI tools to refine their methods. Ultimately, it emphasizes using AI as a collaborative tool to support both counselors and their clients, driving innovation in career counseling practices.

3.3 Latest Developed Models/ Tools Facilitating Personalized Career Pathways (RQ2)

In order to address the second research question, Table 2 provides an overview of the latest developments in terms of tools and models designed to facilitate personalized career pathways along with key details.

Table 2 *Models/ Tools Facilitating Personalized Career Pathways*

S. No	Tool Name	Description	Type	Reference
1	Care Prof Sys	An intelligent job recommendation system utilizing BERT and ontology from the ESCO framework to link education and occupations.	Job recommendation system	(Dascălu et al., 2023)
2	Career Boost	A hybrid recommendation framework combining retrieval-augmented generation (RAG) with natural language processing (NLP) for precise job recommendations	Job recommendation system	(Deshmukh & Bajaj., 2024)
3	Career management system	A career management platform integrating AI, big data, and blockchain technologies.	Career management system	(Jang & Kyun., 2022)
4	Android CMS	An Android-based career management system offering on-the-go career tracking and guidance.	Career management system	(Lee & Joo., 2011)
5	Machine Learning-Assisted Recommendation System (MARS)	A machine learning-assisted system recommending activities to foster competencies like critical thinking and innovation in higher education.	Skill recommendation system	(Wong et al., 2024)
6	Personality Prediction Model for Career Guidance	An ANN-based model predicting career paths by analyzing individual personalities.	Career prediction model	(Rao et al., 2020)
7	Efficient Knowledge Transformation System	Uses paired classifiers to predict students' career choices with high accuracy.	Career prediction model	(Ade & Deshmukh., 2015)
8	Smart Career Guidance System	A Django-powered web application that uses machine learning to simulate personalized career counseling.	Career management system	(Kamal et al., 2021)

3.4 Challenges and Future Research Directions (RQ3 and RQ4) and Limitations of the Study

3.4.1   Challenges in Incorporation of Big Data and AI for Personalized Career Pathways

Although an emerging field, it is crucial to acknowledge that incorporating Big Data and AI into designing personalized career pathways comes with its own set of challenges. The challenges identified in the reviewed studies are outlined below:
1. **Data Privacy and Security***:* Collecting and processing sensitive personal and professional data raises concerns about data breaches and misuse. Ensuring compliance with regulations is critical.
2. **Bias and Fairness:** AI algorithms trained on biased data can lead to discriminatory outcomes, limiting opportunities for certain groups based on gender, race, or socioeconomic status.

3. **Data Quality and Availability:** Personalized recommendations require accurate, diverse, and up-to-date datasets. Incomplete or inconsistent data can reduce the effectiveness of career pathway predictions.
4. **Scalability:** Handling large volumes of diverse data while maintaining system performance and accuracy is technically challenging and resource-intensive.
5. **Ethical Considerations:** Balancing automation with human judgment is necessary to avoid over-reliance on AI, which might overlook nuanced individual preferences or aspirations.
6. **Adaptability to Rapid Changes:** Career trends and industry requirements evolve quickly, and AI systems need frequent updates to stay relevant and effective.
7. **Interoperability:** Integrating AI tools with existing education and career systems can be complex, requiring standardized frameworks and compatibility.
8. **Lack of Transparency:** The black-box nature of many AI models makes it difficult for users to trust and understand the basis of recommendations.

3.4.2   Future Directions
These challenges, when viewed through a constructive lens, highlight opportunities for growth and innovation in the field. Building on these insights, I outline the following five future research directions to advance the use of Big Data and AI in designing personalized career pathways:
1. **Enhancing Inclusivity in AI**: Future research can investigate how AI affects career development for diverse age groups and career stages, ensuring that personalized pathways are equitable and consider the unique needs of various demographic groups.
2. **Integrating Mixed Methodologies:** I encourage the use of mixed methods research in future studies to combine quantitative and qualitative findings, offering comprehensive insights into the lived experiences of employees using AI-powered career development tools.
3. **Strengthening Trust and Acceptance of AI:** Future research should focus on building individual's trust in AI by addressing their fears (e.g., fear of job replacement) and designing of more transparent and secure AI systems
4. **Developing Effective HRD Interventions:** From an organizational context, future research can focus on design and testing of human resource development (HRD) interventions that align AI technologies with organizational goals, ensuring successful integration and positive outcomes for employees' career trajectories.
5. **Addressing Data Privacy and Ethical Concerns:** Future research should explore robust frameworks and technologies to safeguard personal data and address ethical issues, ensuring that AI-driven career pathways respect user privacy and promote fairness.

3.4.3   Limitations of the Study
Despite adhering to best practices and efforts, this study has certain limitations. First, the scope of reviewed studies was restricted, both in number and data source, as only Scopus was used for the literature search. Additionally, the review was limited to English-language publications, excluding potentially valuable insights from non-English literature. The study also focused on literature from three primary academic disciplines: psychology, business and management, and social sciences. Future research could adopt a broader interdisciplinary perspective by including studies from fields such as data science, computer science, mathematics, sociology, and data analytics. Conversely, a more focused approach could also be considered by narrowing the scope to a single discipline, such as business and management or psychology. Lastly, alternative review methods, such as bibliometric analysis or meta-analysis, could be employed in future studies to provide a more comprehensive understanding of this research domain.

4. Conclusion
This study provides an overview by rigorous and transparent attempts toward reviewing the literature pertaining to Big Data and AI in generating personalized career pathways. The findings aim to provide valuable insights for career researchers, career practitioners, counsellors, HR professionals, and a wide variety of populations (e.g., job- seekers, job switchers) in the labor market.

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