



Exploring approaches to overcome challenges in adopting human resource analytics through stakeholder engagement

Shafiq Alam¹ · Zhan Dong² · Indrapriya Kularatne² · Muhammad Salman Rashid¹

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Abstract

As modern enterprises increasingly turn to data-driven decision-making, human resource management (HRM) has also embraced the potential of human resource analytics (HRA) to optimize talent management and gain a competitive edge. However, adopting HRA in practice presents challenges across data governance, technical, and organizational domains. This systematic review, synthesizing insights from 110 studies, identifies key obstacles and practical strategies to address them. Recommendations include fostering a data-driven culture, enhancing training and development, and promoting team collaboration. By tackling these challenges, HR professionals can unlock the full potential of HRA, transforming HRM into a strategic driver of organizational success.

Keywords Human resource analytics · Human resource management · Data-driven decision-making · Stakeholder

JEL Classification O15

✉ Shafiq Alam
salam1@massey.ac.nz

Zhan Dong
dongz4@student.op.ac.nz

Indrapriya Kularatne
indrapriya.kularatne@op.ac.nz

Muhammad Salman Rashid
M.S.Rashid@massey.ac.nz

¹ School of Management, Massey University, Albany, Auckland, New Zealand

² Auckland International Campus, Otago Polytechnic, Auckland, New Zealand

1 Introduction

The emergence of big data and data analytics has sparked a transformation in the business world. Just as analytics have revolutionized marketing, finance, and supply chain management, Human Resource Analytics (HRA) is transforming how human resources (HR) function (e.g., Margherita 2022; Nadkarni and Prügl 2021; Theres and Strohmeier 2023). Ulrich and Dulebohn (2015) defined HRA as a method of studying, evaluating, and optimizing Human Resource Management (HRM) using data analysis and statistical methods.

HRA is becoming a prominent tool for managing the modern workforce, generating significant interest among HR professionals in identifying precise quantitative metrics to enhance and maximize the value of organizational HR (Marler and Boudreau 2017). According to Fernandez and Gallardo-Gallardo (2021), HRA plays a crucial role in data-driven decision-making, improving talent management, boosting employee engagement and well-being, and enhancing workforce planning and operational efficiency. However, some argue that despite the immense benefits of data analytics in HR, it lags behind other management areas in practical application and development (e.g., Margherita 2022; Marler and Boudreau 2017; Rasmussen and Ulrich 2015).

This lag can be attributed to various challenges in HRA adoption. For instance, Rasmussen and Ulrich (2015) noted that HRA faces practical hurdles due to the unique nature of HR data and the need to address privacy concerns, which limits the collection and use of data to transform workforce management. Additionally, the scarcity of expertise in data analytics, statistics, and modeling among HR practitioners is a significant barrier to HRA implementation (Harris et al. 2011). At the organizational level, barriers include shifting from subjective personnel decisions to data-driven HR choices, which require infrastructure changes and the integration of HRA principles into the corporate culture (Levenson 2018). Similarly, Poulouse et al. (2024) recognized organizational barriers as a key challenge in implementing comprehensive data science strategies, matching the challenges faced in HRA adoption. Similarly, Reddy et al. (2022) highlighted the importance of a well-articulated Data Science Strategy as an important component of an organisation's digital transformation process. Moreover, this shift often involves substantial expenses, especially when factoring in investments in technology and specialized personnel (Margherita 2022). Traditionally HR functions are performed by people; therefore, managers and employees might have anxiety over HRA adoption. This indicates the need for organizations to build data-related trust by adapting working cultures and workforce management methods.

Despite these challenges, they should not justify disregarding the potential benefits of HRA in HRM reform. On the contrary, Ulrich and Dulebohn (2015) emphasized the need for HR scholars and practitioners to explore and address these obstacles to unlock HRA's full potential in enhancing HRM practices and fostering organizational success. Thakur et al. (2024) confirmed the direct and indirect utilization of HRA influence both HRM and overall organizational performance, with creative problem-solving capability. This means that HRA can

transform routine practices (e.g., planning, selection, performance management, attrition management, and compensation) and bring long-term shifts (e.g., changes in culture, strategy, and policies). In the past decade, extensive research has scrutinized the intricacies of HRA's application. For example, Marler and Boudreau (2017) evaluated evidence on HRA, providing valuable insights into its current state and positive impact on organizations. Garcia-Arroyo and Osca (2021) systematically reviewed big data analytics' contributions to HRM, discussing opportunities, challenges, limitations, and recommendations for future research. McCartney and Fu (2022a, b) examined the commitment to people analytics and explored the practices and challenges associated with HRA.

While many literature reviews address the challenges of HRA, these discussions remain limited in scope. Much of the existing literature emphasizes the benefits or enablers of data analytics in HRM (Margherita 2022; Marler and Boudreau 2017). Even when challenges are acknowledged, practical solutions are often lacking (Fernandez and Gallardo-Gallardo 2021; Qamar and Samad 2022). In addressing research gaps, Margherita (2022) suggested that future studies should focus on developing best practices for using HRA and explore how to implement it responsibly within organizations. McCartney and Fu (2022a, b) also called for scholars to use factor analysis to strengthen classification within the HRA domain. In addition, a recent study by Qamar and Samad (2022) used bibliometric techniques to analyze HRA's evolution, identify emerging trends, and propose a research agenda. They emphasized the need for future research to examine the challenges and solutions associated with HRA adoption.

To address these issues, this study employs Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) to comprehensively examine scholarly journal papers focusing on HRA challenges and responses, providing a comprehensive perspective in this research area. This research makes a significant contribution by providing a comprehensive exploration of the multifaceted challenges hindering the adoption of Human Resource Analytics (HRA). It systematically identifies and categorizes barriers related to data governance, technical capabilities, and organizational culture while offering practical, actionable solutions that empower HR professionals to implement HRA effectively. By bridging the gap between theoretical discussions and real-world applications, the study equips practitioners with essential tools to navigate the complexities of HRA integration. Additionally, it highlights emerging trends and emphasizes the critical role of stakeholder engagement, ensuring that HRA remains a vital component of Human Resource Management (HRM) and lays a foundation for future research directions. The study's objectives can be summarised into two main facets. Firstly, it aims to cultivate a nuanced and comprehensive understanding of the complex challenges within HRA, systematically exploring the factors hindering its effective adoption. Secondly, it seeks to make substantial contributions by presenting actionable recommendations for practitioners and advancing research directions for scholars. These combined efforts are directed towards promoting the successful and widespread implementation of HRA in organisational practices, ultimately resulting in enhanced workforce efficiency, sustained competitive advantages in talent acquisition, and an overall elevation of organisational

effectiveness. In pursuit of these research objectives, the study has formulated two core research questions.

Research Question 1: What are the key challenges and obstacles faced in the implementation and adoption of HRA within organizational contexts?

Research Question 2: Which stakeholders and what role do they play to actively engage and utilize their influence to address these challenges in implementing HRA strategies and practices?

Following the introduction section, the background section explains the concept and significance of HRA. The remaining sections encompass the research methodology, findings and discussion, limitations and recommendations, and conclusion.

2 Background

Human Resource Analytics (HRA) originated in the 1960s and is currently a vital tool in modern HR management, particularly highlighting the growing importance of data-driven insights in optimizing key HR functions such as recruitment, training, talent promotion, and employee relations. HRA also has a transformative impact on organizational performance and decision-making.

2.1 Human resource analytics (HRA)

Data analytics in Human Resource Management (HRM) is revolutionizing decision-making by utilizing large volumes of employee data to drive insights. HR analytics helps organizations optimize recruitment, assess employee performance, and improve talent management strategies (Margherita 2022; Nadkarni and Prügl 2021). Predictive analytics, for instance, enables anticipating future workforce needs and turnover trends, allowing for more proactive HR planning (Ulrich and Dulebohn 2015). The growing integration of AI technologies, such as machine learning, further enhances these capabilities by automating tasks like resume screening and providing deeper insights into employee behavior, such as engagement and citizenship behaviors (Marler and Boudreau 2017). Heidemann et al. (2024) explored the trade-off between predictive performance and transparency in machine learning for HRM using a real-world dataset and suggested combining machine learning-based inductive methods with traditional deductive methods to fully understand complex HR phenomena. This might help to integrate the subjectivity of HR decisions with the accuracy of objective data. By analyzing historical and real-time data, AI algorithms can identify patterns and recommend actionable strategies, making HR practices more efficient and effective (Thoresen and Strohmeier 2023). However, the widespread adoption of these tools remains hindered by challenges, including privacy concerns, data quality issues, and a lack of data science expertise in HR departments (Harris et al. 2011).

2.2 Evolution of human resource analytics (HRA)

Human Resource Analytics (HRA) is proving to be a transformative force in the field of human resource management, revolutionizing how organizations approach workforce-related decisions. The evolution of HRA can be traced back to the mid-twentieth century, with its roots in industrial and organizational psychology, and has since undergone significant advancements driven by technological progress and a growing recognition of data-driven decision-making in HR practices.

Human Resource Analytics (HRA) emerged as a significant field in the 1960s when managers began exploring more scientific approaches to improve workforce efficiency and effectiveness (Gal et al. 2020). Over the years, technology has been instrumental in transforming HRA into a vital component of HR management. Pesach et al. (2020) outlined this evolution by discussing how machine learning and mathematical programming helped organizations lessen subjectivity and rely on objective data to understand employee needs and behaviours, thereby facilitating informed decisions in areas such as recruitment, training, and performance evaluations. Boudreau and Cascio (2017) provide valuable insights into how HRA utilizes data analysis to manage and optimize human resources within companies. They explain that by leveraging HRA, organizations can collect and analyse employee data to gain valuable insights into performance, skills, potential, and needs. These insights can then be aligned with strategic business goals (Martin-Rios et al. 2017). Furthermore, Newman et al. (2020) explore how HRA employs big data, predictive analytics, and statistical methods to support HR decision-making processes.

Human Resource Analytics (HRA) has garnered significant attention in the academic literature as a powerful tool for enhancing organizational human resource management (HRM). This literature review synthesizes key findings from various studies to elucidate the multifaceted role of HRA and related challenges in optimizing HRM practices.

The literature consistently recognizes the transformative impact of HRA on recruitment processes. Kaushal et al. (2023) and Penpokai et al. (2023) underscore how HRA enables organizations to identify the most effective channels and strategies for attracting and retaining top talent. By employing statistical analyses, HRA can pinpoint the most efficient recruitment methods, optimizing efficiency and quality. Research conducted by Belizón et al. (2024) discovered that HRA is broadening its scope, incorporating an increased utilization of both HR and business data, as well as the application of advanced statistical methodologies. Furthermore, Garg et al. (2022) highlight the potential of advanced techniques such as natural language processing (NLP) to streamline the resume screening process, saving valuable time for recruitment managers.

In the domain of employee training, the literature emphasizes the role of data-driven analytics in optimizing training programs. Tursunbayeva et al. (2022) demonstrate that HRA helps organizations determine which training programs yield the best results and how to allocate budgets effectively to enhance skills and performance. This aligns with the insights of Rasmussen and Ulrich (2015), who argue that such analyses allow managers to make informed decisions that improve training outcomes and return on investment (ROI).

The literature also underscores the importance of HRA in talent promotion. Shah et al. (2017) illustrate how data analytics offers a more objective approach to talent selection, helping organizations navigate the complexities of performance-related data. This evidence-based approach not only aligns employees with roles that suit their strengths but also enhances their engagement and self-fulfilment, ultimately benefiting overall organizational performance by lowering the attrition rate and saving recruitment costs.

Moreover, the literature highlights the critical role of data mining in managing employee relations. Claus (2019) emphasizes that HRA equips organizations to identify and address pressing issues effectively, enabling HR managers to prioritize interventions that boost employee engagement and loyalty. Pessach et al. (2020) further note that a well-implemented HRA strategy can significantly improve retention rates for core staff. Rigamonti et al. (2024) claimed that HRA maturity developed over an evolutionary path which can be explained in distinct stages of maturity that go beyond conventional analytics. Although HRA has evolved into a sophisticated system, there is a need to develop employee trust. For example, Rigamonti et al. (2024) argue that organizations need to establish the legitimacy of HRA systems to improve employee trust and make them share knowledge.

In summary, the existing literature clearly illustrates that HRA, powered by data-driven insights, is essential for optimizing various aspects of HRM. This underscores the necessity for organizations to address existing challenges and harness the full potential of HRA to enhance their effectiveness and performance. The collective findings from these studies emphasize the transformative impact of HRA on recruitment, training, talent promotion, and employee relations and its indispensable role in bringing long-term change in organizational performance and direction.

3 Research methods

Using a systematic review methodology, this study aims to minimize bias and errors by providing an audit trail of the reviewers' decisions, procedures, and conclusion analyses (Moher et al. 2010). The research design is then explained, covering the research process, data retrieval, data screening, and the use of content analysis for data coding and interpretation.

3.1 Research process

Systematic reviews are instrumental in deriving robust and meaningful conclusions through a structured process shown in Fig. 1 (Kitchenham and Charters 2007). The methodology adhered to a structured, transparent approach in goal reviewing and framing scope, selecting relevant scholarly publications, literature analysis, and reporting findings. By following the reporting checklist of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Moher et al. 2010), this study ensures a robust and unbiased analysis of the current research on the challenges and responses to HRA in practice through a systematic literature review.

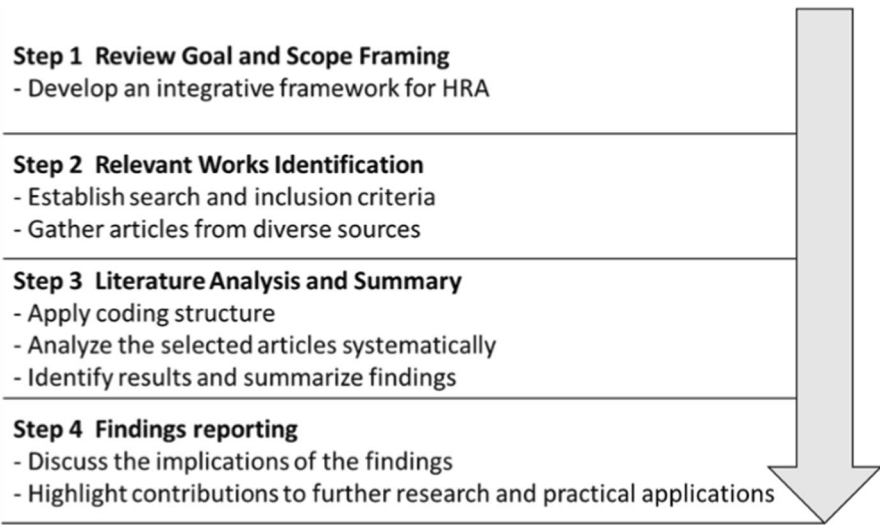


Fig. 1 The proposed screen research process

3.2 Articles retrieval

A comprehensive search strategy utilizing the Scopus and Web of Science (WOS) databases was employed to gather a wide range of articles for the review. As two major multidisciplinary databases, Scopus covers a broader range of journals and contains more articles compared to others, while Web of Science is known for its coverage of the oldest publications (Chadegani et al. 2013; Falagas et al. 2008). Fernandez and Gallardo-Gallardo (2021) emphasized the dual importance of these databases in bibliometrics, as they are key references for extensive literature reviews and primary sources of citation data.

To identify publications relevant to HRA, the search terms were set as "HR analytics," "human resource analytics," "talent analytics," "people analytics," and "human capital analytics." The search encompassed titles, abstracts, keywords, and topics within the Scopus and WOS databases. To focus on HRA Challenges in organisational settings, the search was refined to the "Business, Management, and Accounting" category within Scopus and the "Business economics" category within WOS. Furthermore, strict entry criteria were applied, including selected articles written in English, classified as "articles," and published in reputable journals. Additionally, we did not place any restrictions on publication dates to enable a comprehensive examination of the HRA literature over time.

3.3 Data screening

We used the search tools of Scopus and WOS, and based on the criteria above, 545 articles were retrieved from the Scopus database, while 644 were obtained from the WOS database. These two sets of articles were merged in Excel, resulting in

a comprehensive database containing 970 articles. Among these were 316 articles exclusive to the Scopus database, 427 articles exclusive to the WOS database, and 217 articles in both databases. The inclusion and exclusion criteria is given in Table 1.

Excel and Python were used for their ability to organize, filter, and analyse the large volume of articles by processing the titles, keywords, and abstracts. To maintain the focus of big data analytics in HRM, irrelevant topics were excluded from consideration. These exclusions encompass data analytics specialised in sectors such as social media, healthcare, and tourism, as well as management domains like supply chain, marketing, customer experience, etc. A total of 219 articles focused on HRA have been obtained and will proceed to the next round of screening. Out of the 229 articles obtained, 12 were unavailable as open resources and could not be fully accessed. Following a comprehensive review of the full-text content of the remaining 207 articles, a meticulous screening process led to the identification of 110 articles that specifically addressed the challenges and strategies related to HRA. These selected articles delve into various aspects of HRA, highlighting the obstacles encountered and the corresponding approaches to overcoming them. Therefore, the final scope of this systematic review was determined to encompass the selected set of 110 articles (Fig. 2).

3.4 Content analysis and data coding

To decode the HRA challenges addressed in the selected 101 articles, this study further employed content analysis to examine and code the data. The reason we used content analysis, is that is a systematic encoding and classification method helps to analyse text, exploring the usage of words, their frequencies, relationships, and trends, and patterns in communication and discourse within vast amounts of textual information (Vaismoradi et al. 2013). As illustrated in Fig. 3, Krippendorff's (2004) content analysis framework provided a systematic structure for analysing textual data, facilitating the identification of patterns, themes, and trends within the content. Furthermore, data coding can be conducted in two ways: emergent and priori. Emergent coding establishes categories after a preliminary examination of the data, while priori coding establishes categories based on some theory prior to analysis (Stemler 2015). In line with Stemler's (2015) recommendations, this study will employ a priori coding approach to first analyse 101 articles and refine the coding post-analysis. By systematically analysing and decoding texts, content analysis enables this study to uncover common concerns, challenges, and insights in HRA.

The data coding framework for HRA challenges was refined and adapted based on a study by Fernandez and Gallardo-Gallardo (2021). This approach maximises mutual exclusivity and exhaustiveness within the themes, as Stemler (2015) advocated, aligning the framework with the research objectives. For instance, considering the overlapping content between "Lack of data integration and sharing" and "Insufficient data and metrics" in the article of Fernandez and Gallardo-Gallardo (2021), both were amalgamated as "Data Governance Challenges" in this study. Similarly, "Lack of strategic business" and "Lack of storytelling skills" were consolidated into

Table 1 Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Publication Type	Peer-reviewed journal articles	Non-peer-reviewed articles, conference papers
Language	Articles published in English	Articles not in English
Subject Matter	Studies on Human Resource Analytics (HRA) challenges	Articles on unrelated data analytics fields
Relevance	Directly address HRA challenges and strategies	Focus solely on HRA benefits without challenges
Database	Articles from Scopus and Web of Science	Articles not indexed in Scopus or WOS

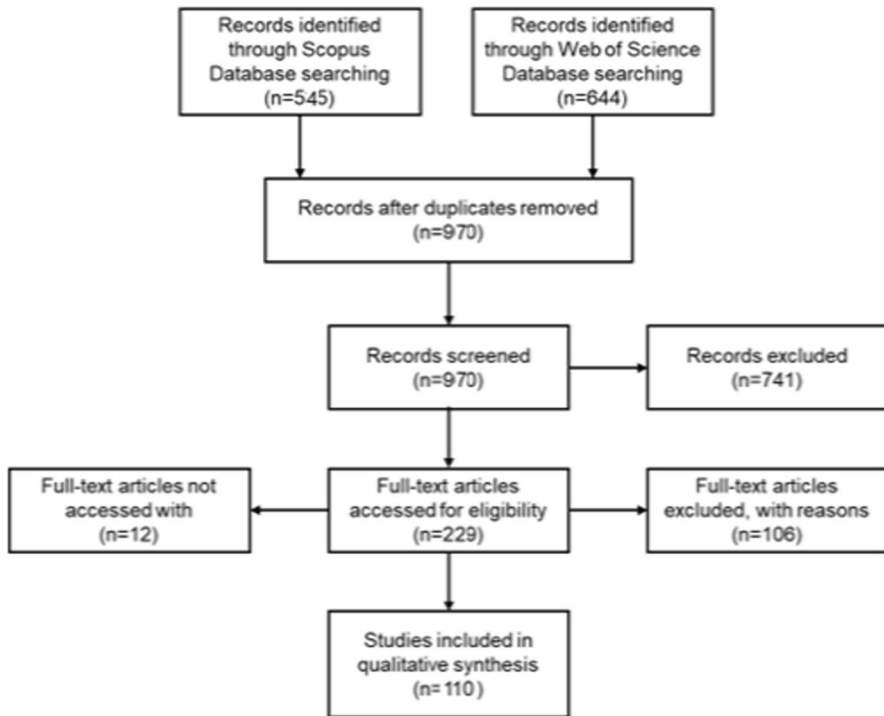


Fig. 2 Article selection process

the theme labelled "Skill Challenges." Ultimately, a comprehensive overview of the data coding framework comprises three major themes: "Data Governance Challenges," "Skills Challenges," and "Organizational Challenges," along with a total of nine sub-themes. By applying this refinement, a comprehensive and precise data analysis was achieved, enhancing the interpretative power of the content analysis (Stemler 2015).

Based on the above data coding, Table 1 shows the classification of themes and the cumulative frequency of occurrences across the 101 articles. Detailed data coding of each article can be found in the *Appendix* "Summary of 101 Articles". Each mention of a particular theme within an article is counted as 1, contributing to the cumulative frequency. The prominence of a challenge within this analysis, as reflected by a higher frequency of occurrence, can be interpreted as indicative of the scholarly community's heightened attention and interest in that specific aspect (Shet et al. 2021) (Table 2).

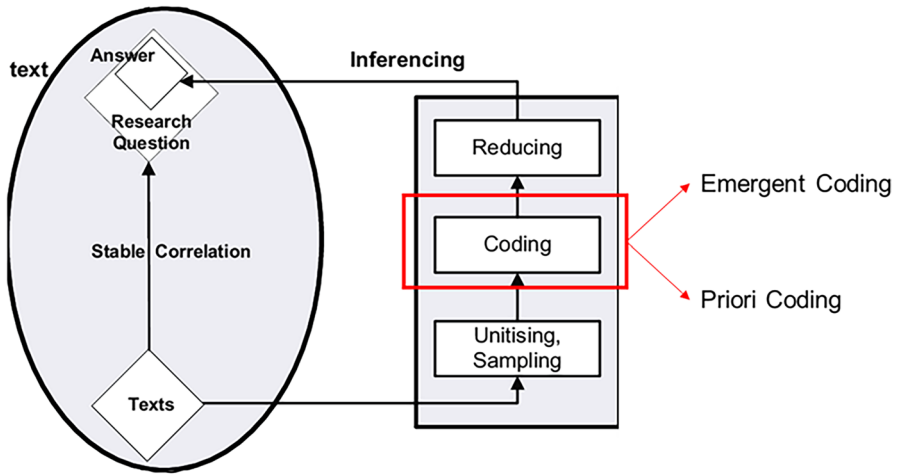


Fig. 3 Content analysis framework

4 Findings and discussion

The guidelines established by Krippendorff (2018) were followed in this study to conduct content analysis, which incorporates both descriptive statistics—such as frequency counts—and interpretive analysis aimed at elucidating and understanding the results. This dual approach facilitates a comprehensive discussion of the significance and implications of the findings, alongside the development of actionable recommendations. Analysis and findings are organized into two different sections to systematically address the research questions. The first section critically evaluates contemporary literature regarding various themes related to challenges in Human Resource Analytics (HRA), utilizing both descriptive statistics and interpretive analysis. The second section provides practical recommendations tailored to diverse stakeholders in response to the identified HRA challenges, again employing interpretive analysis.

Table 2 The theme division and frequency in literature of HRA challenges

Theme	Code	Sub-theme	Frequency
Data governance challenges	D1	Data Privacy and Security Concerns	69
	D2	Data Quality Concerns	67
	D3	Data Fairness and Transparency Concerns	38
	D4	Data Modeling Issues	31
Skills Challenges	S1	Lack of Technical Skills	72
	S2	Lack of Analytical Competency	21
Organisational challenges	O1	Organisational resistance to change	64
	O2	Budget Constraints	30
	O3	Lack of Decision-Maker Support	14

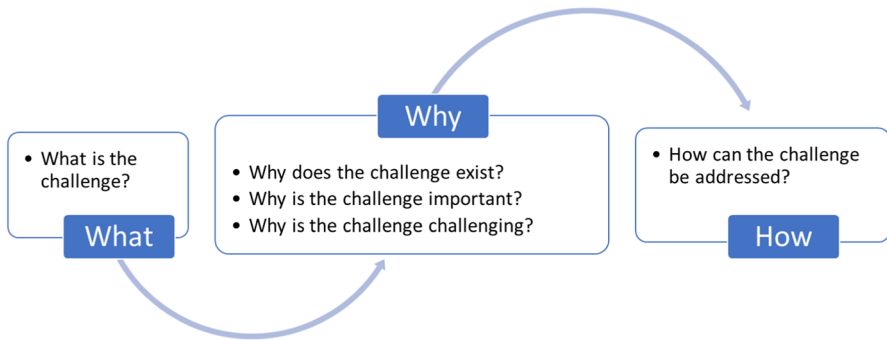


Fig. 4 HRA challenge analysis and mitigation model

Drawing from Neuendorf's (2017) recommendations on interpretive analysis, the HRA Challenge Analysis and Mitigation Model, as illustrated in Fig. 4, has been crafted to examine and address various HRA challenges systematically. This approach thoroughly examines their characteristics, significance, inherent intricacies, and the factors contributing to their existence, as elaborated in the part of **HRA challenges** (What and Why). Each challenge sub-theme will be discussed using this model. Subsequently, this study entails formulating mitigation strategies, as detailed in the **stakeholder recommendations** (How). Using this inductive reasoning helps to deal with the complexity of the study systematically and provides a clear framework for the study to understand better and address the challenges in HRA adoption (Vaismoradi et al. 2013).

4.1 Human resource analytics challenges

This part thoroughly examines the three major HRA challenge themes and their nine sub-themes, covering the definitions, characteristics, contributing factors, significance, and complexities guided by the HRA Challenge Analysis and Mitigation Model (Fig. 4). Table 3 summarises the challenges and different factors.

4.1.1 Data governance challenges

In HRA, data governance challenges refer to the various issues and problems associated with the generation, usage, management, and protection of HR data (Shet et al. 2021). Derived from an analysis of the selected literature, Fig. 5 illustrates the primary challenges hindering the adoption of HRA that have garnered significant scholarly attention. These includes data privacy, security and data quality. Additionally, data fairness and modelling challenges are of significant concern and deserve separate discussion below. Particularly noteworthy is the substantial increase in academic focus since 2020, as indicated by the linear rise.

Data privacy and security concerns (DI): Data privacy is a crucial issue in Human Resource Analytics (HRA), as the field often involves the collection and analysis of sensitive employee information. This data includes personal details,

Table 3 Main themes and features

Theme	Sub-theme	Definition	Key Issues	Significance	Complexities
Data Governance Challenges	Data Privacy and Security (D1)	Protecting sensitive HR data	Compliance, trust issues	Critical for employee data protection	Balancing privacy with business needs
	Data Quality (D2)	Ensuring accurate and complete HR data	Fragmentation, varying standards	Essential for reliable analytics	Managing diverse data sources
	Data Fairness (D3)	Avoiding bias in HR data	Bias in collection and analysis	Important for fair decision-making	Balancing transparency with privacy
	Data Modelling (D4)	Analyzing HR data effectively	Lack of standardization and complex data types	Vital for informed HR decisions	Ensuring clear and interpretable models
Skills Challenges	Lack of Technical Skills (S1)	Insufficient data analysis skills	Focus on soft skills over technical training	Hinders effective HR analytics	Addressing skill gaps in HR
	Lack of Analytical Skills (S2)	Inadequate analytical competencies	Misalignment of HR roles and analytical needs	Prevents misinterpretation of data	Aligning HRA with business objectives
Organizational Challenges	Resistance to Change (O1)	Opposition to HRA adoption	Fear of job loss, cultural inertia	Impacts organizational adaptability	Managing change resistance
	Budget Constraints (O2)	Financial limitations on HRA	Resource prioritization issues	Limits HRA implementation	Balancing budget with strategic needs
	Lack of Decision-Maker Support (O3)	Insufficient leadership backing for HRA	Misalignment with organizational goals	Crucial for HRA success	Engaging leadership in HRA value understanding

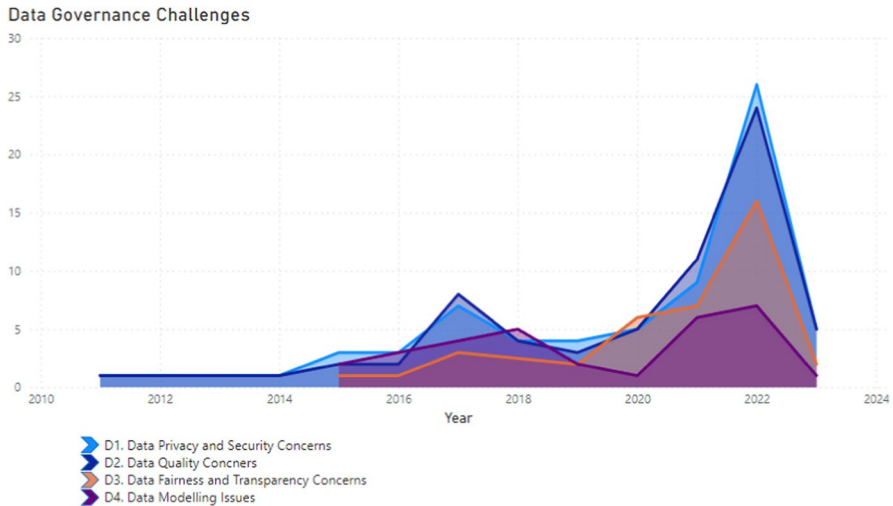


Fig. 5 Frequency of data governance challenges

performance appraisal, and compensation records, all requiring stringent protection. Shah et al. (2017), define data privacy as the safeguarding of personal information from unauthorized access, use, or disclosure. Complementing this, Rasmussen and Ulrich (2015) highlight data security as the measures designed to protect digital information from similar threats, including interference, modification, or destruction.

The significance of both data privacy and security in HR is underscored by Marler and Boudreau (2017), who argue that organizations must prioritize these aspects to protect sensitive employee data. Failure to do so can lead to serious repercussions, including non-compliance with data privacy regulations and increased legal liability (Gotsch and Schögel 2023). Thus, effectively managing data privacy and security poses a significant challenge for HR professionals navigating the complexities of analytics. It means that employees may not be interested in providing true data that could compromise the decision quality and, ultimately less optimal workforce management. Organisations need to establish data management infrastructure and processes to mitigate these risks.

Similarly, Hamilton and Sodeman (2020) discussed HR data security issues in the U.S. business environment for legal and ethical concerns, including the inadvertent violation of Title VII of the U.S. Civil Rights Act, the Equal Employment Opportunities Act, the Americans for Disabilities Act (ADA), equivalent European Union regulations such as the Employment Equality Framework Directive, and other job discrimination laws and regulations. Penalties for breaching data privacy regulations can cause significant financial losses to organisations (Cayrat and Boxall 2022). Turunbayeva et al. (2022) suggested that based on the General Data Protection Regulation (GDPR) in the European Union, organisations that fail to safeguard or misuse personal information may face fines of up to €20 m or 4% of annual worldwide

turnover. In addition to the risk of a breach, Hamilton and Sodeman (2020) pointed out that employees' trust is one of the key factors in organisational success. Whether a legal or trust crisis, it will cause irreparable reputational and financial damage to the organisation.

Dealing with data privacy and security issues is challenging, especially in the HRM domain. As more countries and regions introduce data privacy and security regulations, organisations must comply with different regulations and standards, which adds to the complexity of HR data security (Böhmer and Schinnenburg 2023). Another reason illustrated by Van Den Heuvel and Bondarouk (2017) is the thin line between privacy intrusion and business progression. As more data becomes available and new forms of data are collected, it becomes increasingly challenging to determine what data to use and how to utilise and protect it. Additionally, Levenson (2018) emphasised that the decentralised nature of HR data makes data privacy and security more difficult, as they are often stored in different systems and applications and need to be shared between different departments and people. Therefore, organisations should start with a data management philosophy and then establish robust infrastructure to protect data. Further, continuous review is needed of data collection, storage, and usage policies.

Data Quality Concerns (D2): Van Den Heuvel and Bondarouk (2017) defined HR data quality concerns as incompleteness, inaccuracy, inconsistency, timeliness and unreliability, which may lead to inaccurate and unreliable analytical results. According to Shet et al. (2021), the quality of the data used in HRA is very important because HR data contains information about multiple processes in HRM, and HR decisions based on data metrics can only be made when the accuracy of the data is ensured.

However, data quality issues have consistently presented a significant challenge, impeding the progression of HRA, primarily due to the unstructured, fragmented, and incomplete nature of HR data (Marler and Boudreau 2017). Hamilton and Sodeman (2020) noted that many HR datasets are not part of the HR system but are spread across multiple parts of the organisation, such as marketing, production, customer service, etc. As a result, the standards and quality of HR data can vary widely. For example, Martin-Rios et al. (2017) pointed out that methods of calculating employee turnover and performance appraisal measures may differ across various divisions and functions within the same organisation. Another reason is that HRA necessitates collecting a significant amount of HR data, which could be challenging for small and medium-sized enterprises (SMEs), potentially affecting the accuracy and reliability of the analysis (Strohmeier et al. 2022). Data quality might be maintained by regular updates of the templates and platforms and by training managers in effective data collection strategies.

Data fairness and transparency concerns (D3): McCartney and Fu (2022a, b) defined data fairness as ensuring that data are not biased by personal characteristics (e.g., gender, race, age, etc.) during the data collection and analysis. This is vital because biased data can lead to unfair decision-making, ultimately affecting organisational performance (Hastuti and Timming 2022). HRA heavily relies on data analytics and algorithms to gain insights into employee behaviour, performance, and engagement (Gal et al. 2020). To make informed HR decisions, the algorithms used

must consider the diversity and variability within the workforce, as highlighted by Garcia-Arroyo and Osca (2021), to ensure fairness and transparency in HR processes. Lack of clear and comprehensible transparency in employee assessments can lead to perceptions of unfairness, resulting in dissatisfaction and potentially undermining the employer-employee relationship, as highlighted by Zhou et al. (2021). This situation can also raise significant ethical and legal concerns. For example, Minbaeva (2021) pointed out that IBM's implementation of a poorly designed algorithm for evaluating employee performance yielded higher scores for relatively new employees, creating biased outcomes that adversely impacted employee morale and productivity.

The issues surrounding HR assessments are multifaceted. First, HR data may suffer from incompleteness and inaccuracies, which can result in discriminatory outcomes (Newman et al. 2020). Additionally, Karwehl and Kauffeld (2021) emphasized that the increasing complexity of data collection and storage raises the risk of undetected errors and data incidents. Algorithms may inadvertently display biases, favoring certain subsets of data while neglecting others. Moreover, in HRM practices, achieving a balance between data transparency and protecting employee privacy remains a complex challenge (Peeters et al. 2020). Chatterjee et al. (2022) advocated for organizations to consistently employ fair data collection methods, implement unbiased algorithms, and critically assess the justifiability of HR analytics results. Undertaking critical analysis of the data input and employee outcomes might mean an additional workload for HR and line managers in the initial phases of the HRA implementation. However, it would greatly enhance the system's robustness and trustworthiness.

4.2 Data modelling issues (D4)

The challenges associated with data modelling in Human Resource Analytics (HRA) are both significant and complex. Boudreau and Cascio (2017) describe data modelling as the process of using statistical, mathematical, and computational methods to transform HR data into models that facilitate analysis, prediction, and optimization. This process involves several key steps, such as data collection, cleansing, transformation, modelling, evaluation, and interpretation. Each of these steps plays a crucial role in analysing HR data to uncover insights into employee behaviour, performance, satisfaction, and other important work and wellbeing outcomes (Levenson 2018).

Despite its importance, effective data modeling encounters various hurdles. Srivastava and Eachempati (2021) emphasize that while this modeling is essential for making informed decisions and enhancing organizational performance, issues of fairness, transparency, feature selection, and model interpretability often complicate matters. Tursunbayeva et al. (2022) highlight how these challenges can overshadow basic considerations, making it difficult to develop models that are both equitable and comprehensible.

One major issue arises from the tendency for poorly structured analytical frameworks to lead to decisions based on incorrect assumptions or incomplete data. Shet

et al. (2021) note that a lack of rigorous logical structure can result in outcomes that are difficult to explain, leaving stakeholders without clear rationales for decisions. Similarly, Calvard and Jeske (2018) argue that the absence of standardized data inputs and outputs contributes to the creation of flawed algorithms and models.

Furthermore, the rapid advancement of technology and the large-scale collection of HR data have introduced a variety of data types, including quantitative, qualitative, and textual data. This complexity requires the implementation of highly structured algorithms and models capable of effectively processing and analyzing this diverse information (Karwehl and Kauffeld 2021). As organizations strive to leverage HRA's potential, tackling these challenges becomes essential to ensure that data-driven decisions are fair, transparent, and grounded in robust analytical frameworks. Perhaps better coordination between people designing algorithms/models and managers using these systems can address this challenge, which requires a bottom-up approach to feedback.

4.2.1 Skills challenges

HR staff lacks data analytics competencies, which presents a major hurdle in HRA implementation. As Fig. 6 shows, the lack of HRA-related technical skills is a common focus for scholars, followed by analytical skills, which will be discussed separately below.

Lack of technical skills (S1): Marler and Boudreau (2017) identified the lack of technical competencies among HR professionals as a major challenge for HRA in practice, as their lack of skills in areas such as statistics, data mining, and machine learning leads to substantial limitations in processing and analysing data. Hülter et al. (2024) interviewed non-machine learning experts about their reasoning for using a specific tool tailored to a public sector organization, corresponding to the typical end-user perspective of machine learning-based HRA adoption, and

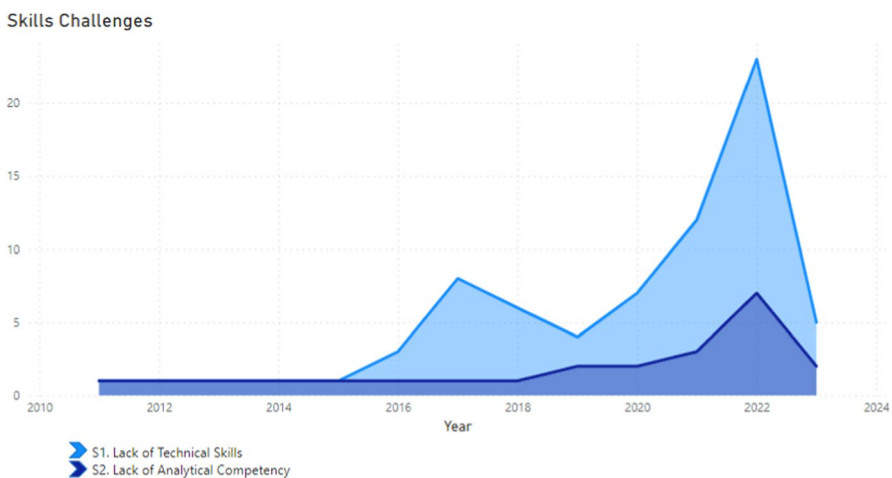


Fig. 6 Frequency of skills challenges

identified relevant beliefs and experiences influencing the intention to adopt machine learning-based HRA, qualitatively linking these beliefs to machine learning characteristics such as transparency, automation, and fairness. King (2017) highlighted that HRA must use various technology tools and software to collect, store, analyse and visualise data. HR professionals cannot use these tools and software effectively without technical skills. Consequently, HR professionals often fail to comprehend and respond to digital transformation challenges and opportunities, hindering their ability to offer valuable strategic advice through effective cross-departmental collaboration (Zhou et al. 2021).

Indeed, the lack of technology skills among HR professionals is a common phenomenon. Traditionally, HR professionals have focused on interpersonal and communication skills rather than technology and data analysis (Schiemann et al. 2018). Andersen (2017) noted that HRA is a relatively new field, and many HR professionals may not have received relevant training or education, thus lacking the necessary technical skills. Srivastava and Eachempati (2021) further stated that HR professionals are unaware of the importance of technology skills for HRAs, and they believe that technology and data analysis is the responsibility of the IT department, not theirs. Developing employee competencies and training them in data analytics might be particularly challenging for SMEs because they lack human and financial resources (Arief et al. 2021). Organisations could liaise with higher education institutions for the future supply of key data competencies and support them in incorporating such skills in their HR curriculum.

Lack of analytical skills (S2): In addition to technical limitations, the lack of analytical competency among HR professionals is another significant factor constraining the widespread adoption of HRA. As suggested by Falletta and Combs (2021), while IT professionals can often supplement technical skills, HR professionals bear the primary responsibility for a broader range of analytical competencies, such as data interpretation, insight extraction, business acumen, and ethical awareness. Rasmussen and Ulrich (2015) emphasised that misinterpreting and misusing HRA results can lead to significant consequences, including resource wastage, performance reduction, or missed business opportunities. Furthermore, Margherita (2022) proposed that the misuse of HRA can potentially lead to severe legal issues, such as violations of the European Union's General Data Protection Regulation (GDPR).

Preventing misunderstandings and misuse of HRA is a challenging endeavour, given its reliance on vast data and intricate analytical techniques. Achieving this necessitates the expertise and skills to interpret and employ analysis results accurately (Pessach et al. 2020). Qamar and Samad (2022) stressed that this encompasses not just tool usage but also critical thinking, method design, business context comprehension, trend interpretation, and insight-driven recommendations. HR analysts, according to Wang and Katsamakos (2019), must effectively communicate analysis outcomes to decision-makers, hinging on a deep grasp of business needs and insights. Moreover, Penpokai et al. (2023) emphasised the significance of analytical competency in effectively applying these skills to address real-world issues and ensuring alignment of analysis results with organisational objectives. A lack of analytical skills and the resultant barriers to making data-driven decisions are likely to prevent HR professionals from contributing to the strategic direction of the business.

Organizations could introduce mentoring programs where HR staff work with top managers and people from other functions (e.g., marketing and finance) to learn the analytical usage of HRA outputs.

4.2.2 Organisational challenges

In addition to the data and skills aspects, challenges at the organisational level also significantly impede the widespread adoption of HRAs. According to Fig. 7, "organisational resistance to change" is the most prominent reason with "budget constraints" and "lack of decision-maker support" following closely.

Organisational Resistance to Change (O1): According to Ulrich and Dulebohn (2015), the emergence of HRA signalled a change in the HR landscape from traditional HRM to more data-driven HRA. This change could be resisted and opposed by employees, management structure and organizational culture. Shah et al. (2017). One of the reasons is the impact that the wide use of HRA may have on the interests and welfare of employees, such as redundancies, pay reduction, and absence of human interaction and empathy (Margherita 2022). Vargas et al. (2018) also highlighted the risks and uncertainties associated with change, such as increased costs, business disruption, etc., which may make it difficult to realise change. Claus (2019) further examined the consequences of this resistance, which results in organisations being unable to adapt to changes in the market and business environment promptly, as well as wasting organisational resources such as time, money and people. Organisational behavior experts need to be consulted when implementing the HRA system because managers and employees will be disengaged and dissatisfied if they do not trust the system.

Budget Constraints (O2): At the organisational level, financial budget constraints are another notable obstacle to the widespread application of HRA technologies and

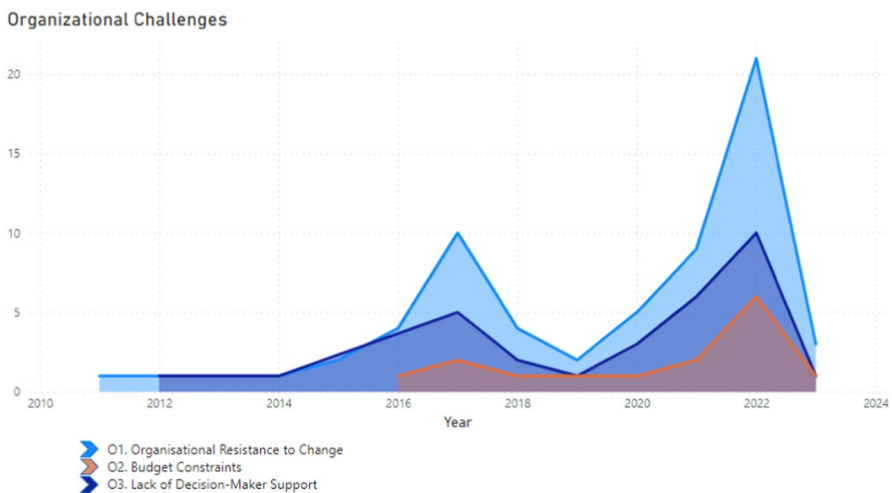


Fig. 7 Frequency of organisational challenges

practices (Fernandez and Gallardo-Gallardo 2021). First, Zhou et al. (2021) noted that the digital transformation of HRM requires significant investment in technology equipment, software, training and human resource. It is difficult for organisations on tight budgets to achieve full utilisation of HRAs to improve business performance. Martin-Rios et al. (2017) argued that although organisations may have allocated a budget, additional costs often arise during HRA implementation, resulting in the expected results not being achieved. Second, resource distribution within the organisation is based on business priorities, and the importance and value of the HRA project investments are often overlooked in favour of smaller budget allocations (Van Der Togt and Rasmussen 2017). Further, Margherita (2022) pointed out that budgetary constraints may result in an inability to attract and retain talent that specialises in HRA, thus affecting the quality and effectiveness of HRA, further making it severely undervalued. HR professionals could present an effective proposal and strive to win the commitment of top managers to address this issue. The implementation cost might be significant, but the returns in the shape of streamlined talent practices and long-term transformation will likely outweigh the costs.

Lack of decision-maker support (O3): Budget allocations often reveal the preferences of the organisation's decision-makers. The lack of support for HRA from decision-makers is another major problem with HRA (King 2017). Boudreau and Cascio (2017) stressed that the value of HRA lies in the need for HR professionals to translate HRA results into practical action and provide useful information to decision-makers. How to reflect the value of HRA to decision-makers, including the organisation's top management and line managers other than HR managers, must be addressed on the road to HRA practice (Shet and Nair 2022). Fu et al. (2023) indicated that when HRA deviates from the strategic goals and business needs of the organisation, the results of the analysis hardly provide useful information for decision-makers. This underscores the importance of ensuring alignment between HRA and the organisation's goals and requirements. HR function need to emerge as a strategic partner to convince top managers about the value of investing in HRA.

4.3 Practical recommendations to stakeholders of human resource analytics

To conclude the "What and Why" aspects of the HRA Challenge Analysis and Mitigation Model (Fig. 4), given the comprehension of the manifold HRA challenges, the query emerges: What practical recommendations can be devised for different stakeholders in adopting HRA (Angrave et al. 2016)? In this section, we aim to bring together a range of practical measures that can offer valuable guidance to the various stakeholders involved in HRA adoption and management, including top management, HR departments, IT teams, and employees. By doing so, we can clarify the distinct roles each stakeholder plays in the HRA process. This clarity will help organizations develop clear strategies for effectively leveraging HRA, ultimately leading to improved organizational performance. Table 4 shows the summary of the recommendations with its relevant themes.

Table 4 Recommendations at different level and relevant themes

Stakeholder	Theme IDs	Recommendations
Top Management	O1, O2	Support HRA in strategic planning Design a data philosophy and promote a data-driven culture Invest in technology and training
HR Managers & Team	S1, S2	Manage HR data effectively Develop HRA talent Communicate insights clearly
IT Managers & Team	D1, D2	Maintain HRA infrastructure Ensure data security Collaborate with HR on governance Train HR staff
Employees	O1	Engage in HRA processes Provide honest feedback Understand data privacy rights

4.3.1 Recommendations for top management

Top management plays a vital role in harnessing the power of Human Resource Analytics (HRA) to drive competitive advantage. Research by Alamelu et al. (2017) shows that CEOs view HRA as essential for success. To make the most of HRA, top executives—such as the CEO, CFO, and COO—should prioritize its integration into their strategic planning. This means actively promoting a data-driven culture within the organization and encouraging collaboration across departments (Mondy and Martocchio 2016). By leveraging HRA effectively, leaders can not only enhance decision-making but also foster a more agile and responsive organization (Shet et al. 2021).

First and foremost, top executives must actively support the implementation of HRA. This not only relies on HR practitioners to demonstrate the value of HRA but also necessitates proactive engagement from top executives (Edwards et al. 2022). People are the most important resource for organisations, and objective management of this resource via HRA could transform the decision-making process of organizations by empowering evidence-based approaches (Ratnam and Devi 2024). As pivotal drivers responsible for shaping the organisation's HR strategic direction, top management must possess the foresight to recognise the potential value of HRA and grasp its multifaceted advantages for the organisation (Wang and Cotton 2018). These encompass more streamlined talent acquisition processes, equitable employee performance management, targeted training and development initiatives, and optimised strategic planning (Jain and Jain 2020). HRA should be perceived not merely as a data collection and analysis tool but as a strategic instrument empowering organisations to make informed talent-related decisions. For example, losing talented individuals to competitors could jeopardize organizational success; data analytics might be used to reduce unwanted attrition and quiet quitting by identifying

early signs and understanding root causes using engagement surveys and performance matrices. Senior executives should acknowledge that HR risk assessment constitutes a long-term investment rather than an ad-hoc arrangement (Polyakova et al. 2020).

Secondly, a strong financial commitment is essential for the successful implementation of Human Resource Analytics (HRA). Research by Shet et al. (2021) indicates that organizations willing to make an upfront investment and navigate initial uncertainties are better positioned to support effective HRA practices. This investment should encompass advanced technology, training, cutting-edge analytical tools, and robust data security measures.

Involving external experts and consultants can significantly enhance the HRA implementation process, as noted by Marler and Boudreau (2017). While it's crucial to recognize that HRA may require a longer payback period, this should not overshadow the need to assess its efficiency.

Top management should clearly outline the strategic HR objectives linked to HRA and ensure these align with the organization's long-term vision (Vargas et al. 2018). Additionally, Hamilton and Sodeman (2020) emphasize the importance of regularly measuring and evaluating the effectiveness of HRA practices. This ongoing assessment will help identify areas for improvement and ensure that HRA continues to deliver meaningful benefits.

Moreover, in change management, executives must exert significant influence in fostering a data-driven culture within the organisation (Ulrich and Dulebohn 2015). During the initial phases of establishing such a culture, a work environment should be cultivated that encourages innovation and allows room for experimentation and learning from mistakes (Karwehl and Kauffeld 2021). Employees must feel encouraged to explore new HRA methods and strategies in controlled, smaller-scale settings without fear of repercussions, with the provision of support and feedback in case of failure. Special bonuses, promotion opportunities or other forms of incentives and rewards for innovative use of HRA can be effective motivators for successful HRA implementation (Alamelu et al. 2017). Simultaneously, top management can foster a culture of knowledge sharing and internal learning by encouraging teams to share their experiences, both successes and failures, in implementing HRA (Fernandez and Gallardo-Gallardo 2021). The knowledge-sharing process plays a crucial intermediary role, representing tacit and explicit knowledge coordination can only yield benefits when organizations have implemented effective sharing-knowledge systems (Rasheed et al., 2024). This not only helps prevent the repetition of mistakes but also provides greater transparency, allowing ordinary employees to understand the purpose, process, outcomes, and impact of HRA on employees and the organisation. This approach can establish trust and engagement among employees regarding the operation of HRA and also aid in mitigating challenges related to data governance. It is equally important to align top managers' support with routine processes, where HR professionals and line managers could train employees in data analytics and incorporate such competencies into performance appraisal to encourage growth.

4.3.2 Recommendations for HR managers and HR team

HR managers play a pivotal role in transforming the strategic vision set by top management into actionable HR plans that serve HR decision-making (Rombaut and Guerry 2018). According to Shet and Nair (2022), HR managers and their teams are the primary stakeholders in HRA practice, including data collection, data management, infrastructure and technique implementation, interpretation, and communication. These multifaceted roles contribute significantly to enhancing the effectiveness of HRA implementation.

Firstly, HR staff collects and maintains employee data. They ensure the effective collection of key HR data from various sources, including HRIS, selection records, employee surveys, performance evaluations, training records, and exit interviews (Peeters et al. 2020). The critical HR data encompass employee demographics, performance and development metrics, job satisfaction and engagement, and turnover rates (Jain and Jain 2020). Further, HR managers should pay attention to the cleansing and processing of data by assigning specialised HR data administrators to address issues such as missing data, outliers and duplicate data to ensure data reliability. Meanwhile, HR departments should also work with IT departments to ensure data security and compliance (Khan and Tang 2017).

Secondly, as HRA technique implementers and experts, HR managers and teams are responsible for effectively deploying HRA. HR managers are not only required to excel in data analytics but also play a proactive role in identifying and nurturing HRA talent within their organisations, eventually developing an internal team of HRA experts (Fu et al. 2023). The various avenues include recruitment, training initiatives, external collaborations, and incentivising innovative practices (Shet et al. 2021). In today's fast-paced technological landscape, enhancing analytical skills is of paramount importance. On one hand, technological advancements have reduced the necessity for programming skills in HRA, thus lowering the barrier to entry for HRA professionals (Edwards et al. 2022). On the other hand, emerging technologies like AI and natural language processing are revolutionising HR practices by automating tasks like CV screening and employee survey analysis, resulting in substantial enhancements in HRA efficiency (Pillai and Sivathanu 2020). Overlooking these advancements could potentially lead organisations to lag in talent acquisition and management. Therefore, HR managers should prioritise the acquisition of robust data analytics skills as a means of gaining a competitive edge. It is equally important to cultivate an agile learning environment where employee continuously develops their data analytics skills, especially their analytical skills.

Thirdly, HR managers and teams are the interpreters and communicators of HRA results. They must convey complex data analytics outcomes concisely and meaningfully to various organisational stakeholders, including top executives, line managers, and employees (Fernandez and Gallardo-Gallardo 2021). To achieve this, HR managers must take the lead in enhancing soft skills such as insights and interpretation of analytics results (Ulrich and Dulebohn 2015). Boudreau and Cascio (2017) suggested that the HR team should excel in data visualisation and communication, translating intricate analytics into actionable insights that facilitate decision-making. It is imperative to possess the capacity to craft lucid and comprehensible data

visualisation tools and reports (Chatterjee et al. 2022). This approach ensures that non-technical and generalist employees can also understand and utilise data, increasing their understanding and trust in data-driven HR decision-making (Levenson 2018). The HR department can design training interventions and coaching programs where experienced and high-performing employees help other employees understand and communicate HR data effectively.

Lastly, HR managers and teams need to regularly scan the industry trends and strategic direction of the business and update the HRA system to incorporate new and innovative methods of managing the workforce (e.g., the recent practice of using geolocation technologies to recruit and retain talented employees, see Shevchenko and Reips 2024). This might mean regularly updating the tools and techniques of data collection, analysis, and communication to different stakeholders.

4.3.3 Recommendations for IT managers and IT team

Due to the extensive use of IT technologies in HRA, IT managers also play an irreplaceable role in addressing HRA challenges. On the one hand, IT managers and their teams provide technical support, particularly in data modelling and HRA algorithm construction, to ensure the successful implementation of HRA projects (Pesach et al. 2020). On the other hand, IT managers also actively lead the development and execution of data governance frameworks to safeguard data quality and privacy (Boudreau and Cascio 2017). Here are some practical recommendations.

Firstly, IT teams manage and maintain the technical infrastructure required for HRA projects, including data storage, processing, modelling, and analytics tools (King 2017). They need to ensure the stability and security of these systems to minimize interruptions in HRA projects. Also, IT managers should maintain a keen awareness of emerging technologies and tools, consistently enhancing the technical capabilities of their teams (Kim et al. 2021). As technology evolves, novel tools and techniques can potentially enhance HRA's efficiency and precision. Meanwhile, IT teams typically comprise highly skilled technical experts within the company, capable of spearheading the advancement of technological intelligence across the entire organisation (Claus 2019). Martin-Rios et al. (2017) suggested that IT managers can motivate their teams to acquire and implement these innovations through incentive measures linked to IT personnel's performance.

Furthermore, IT should cultivate a close and collaborative partnership with the HR team in developing HR data governance frameworks. McCartney and Fu (2022b) emphasised that in pursuit of the organisation's overall strategic objectives, IT managers should possess a strategic organisational perspective that transcends departmental boundaries, actively engaging in companywide HRA initiatives while providing support and leadership. Given the critical role of data in HRA, establishing well-defined rules and standards is imperative to safeguard data quality, privacy, and impartiality (Bartram and Cooke 2022). Unlike HR professionals, IT employees are highly specialised in data technology, possessing a profound comprehension

of the technical prerequisites, intricacies, and constraints linked to data (Gal et al. 2020). Subsequently, they can engage in joint efforts with the HR team to formulate data collection, storage, processing, and sharing protocols. Wirges and Neyer (2022) suggested that conducting of routine HR-IT coordination meetings can facilitate the creation of effective communication channels, ensuring seamless collaboration between the two departments. This collaborative approach enables them to address challenges collectively and propel the advancement of HRA projects (Shet et al. 2021). Such collaboration should be recognized and endorsed by the top management.

4.3.4 Recommendations for employees

Employees constitute the majority within an organisation, and their role in addressing HRA challenges should not be undermined (Minbaeva 2021). On the one hand, employees serve as the data producers, generating a plethora of data related to performance, engagement and well-being, and work-related metrics through their daily activities (Jain and Jain 2020). On the other hand, employees are the primary subjects of HRA practices. Metrics such as employee performance and job engagement are used to assess organisation's overall performance and can also influence individual career development and compensation. While employees may not directly engage in data analysis and decision-making in the context of HRA, their work attitudes and behaviors directly impact the data quality and effectiveness of HRA (Martin-Rios et al. 2017).

First and foremost, employees should recognise themselves as beneficiaries of HRA, which can lessen the change resistance and help generate accurate and timely data (Karwehl and Kauffeld 2021). According to Peeters et al. (2020), HRA offers numerous benefits to employees, including a better understanding of their performance and contributions, leading to improved rewards and promotion opportunities. Levenson's (2018) research also highlighted that data analysis can uncover employees' growth potential, enabling them to leverage their talents fully. Therefore, employees should actively participate in employee surveys, providing honest feedback and suggestions to assist HR teams in identifying and addressing potential issues of HRA (Al-Mkhadmeh et al. 2022). Such a proactive attitude and engagement will fundamentally change the organisation's resistance to HRA (Garcia-Arroyo and Osca 2021). It is important to note that some employee behaviors are transient in nature; therefore, the data collection should be scheduled around such events to mitigate recall and social desirability biases.

Employees' active engagement with the HRA system is crucial for its success. Employees can even proactively provide data and information regarding their work performance, such as project achievements and improvements in key performance indicators, to help HR teams gain a more comprehensive understanding of their contributions, thereby effectively showcasing their value within HRA (Arora et al. 2022). Additionally, while employees may not be professional data analysts,

they can still enhance their data literacy, which is crucial for better understanding and leveraging HRA results (Van Der Togt and Rasmussen 2017). Employees can actively seek training and learning opportunities to acquire fundamental data analysis and interpretation skills. This will enable them to comprehend better the data and metrics presented in HRA reports, leading to a deeper understanding of their career development opportunities.

Lastly, throughout the entire process of HRA practice, employees should not overlook the importance of safeguarding their personal data privacy (Rombaut and Guerry 2018). Employees should be aware of their data rights and their organisation's data privacy policies, ensuring that their personal information is processed and protected by the organisation in a transparent and legal manner. These measures will contribute to employees' better adaptation to and utilisation of HRA, ultimately resulting in a win-win situation for both employees and the organisation (Ryan 2021).

5 Contributions and implications

5.1 Theoretical implications

This research provides theoretical contributions to HRA literature by providing a literature-driven framework for understanding challenges in data governance, skills, and organizational characteristics. It introduces a stakeholder-centric approach to HRA implementation and links the gap between data governance principles and theory, contributing to ethical practices. Our study covers the modern HR view by illustrating how HRA can be a strategic resource. The introduced HRA Challenge Analysis and Mitigation Model offers a systematic framework for examining and addressing HRA-related challenges across different levels. These contributions collectively advance our understanding of HRA implementation and provide a foundation for future research in this evolving field. Our research also extends stakeholder and strategic management literature by presenting HRA as a key strategic resource and indicating the important role of key parties in its implementation. Future research can empirically test and improve our proposed framework.

5.2 Managerial implications

This study proposes several managerial implications for organizations implementing HRA. It highlights the requirement for a holistic approach to HRA adoption, addressing challenges across data governance, skills, ethics, and organizational domains. Managers should prioritize developing strong data management practices, investing in training employees, and fostering a data-driven culture. The research emphasizes the importance of stakeholder engagement, suggesting that managers at all levels of organisations should be involved in HRA initiatives. HRA holds a strategic value, and managers must be encouraged to align analytics practices with broader business objectives. By addressing these aspects, organizations can enhance

their HRA capabilities, leading to more informed decision-making and improved organizational performance and employee well-being.

6 Limitations and recommendations for future research

This study encompasses a comprehensive literature review of 101 articles, with the aim of encompassing the entire chronology since the introduction of the term "Human resource Analytics" in scholarly discourse. While the scope was as extensive as possible, the possibility of overlooking some pertinent research papers still exists. Given that HRA is a relatively nascent field with continually emerging research outcomes, omitting the latest research is plausible. To mitigate this limitation, future research may consider periodically updating the literature review to ensure coverage of the most recent research developments (Qamar and Samad 2022). Using research methodology of content analysis, this article employs data coding and synthesis methods to categorise HRA challenges into three major themes and nine sub-themes. While an a priori approach was used, with revisions based on the study of Fernandez and Gallardo-Gallardo (2021), to minimise subjective biases, complete elimination of such biases may not be attainable. To enhance the objectivity of future research, it is advisable to employ multiple researchers for independent assessment and analysis of the literature to validate the consistency of results (Neuendorf 2017).

Moreover, this study's focus on generic organisational settings when addressing HRA challenges and mitigation strategies might not capture the nuanced complexities faced by organisations of varying sizes, industries, and geographical locations. These contextual factors can significantly influence the acceptance, implementation, and challenges associated with HRA (Bechter et al. 2022). For instance, SMEs typically face resource constraints, such as limited budgets and technical capabilities, while large multinational corporations with more substantial resources and infrastructure may approach HRA adoption differently (Gobble 2017). Additionally, industry-specific regulations, data availability, and competitive landscapes can shape how different industries engage with HRA and the specific challenges they encounter (McCartney and Fu 2022a). Geographical regions also influence the HRA landscape due to legal and cultural factors and skilled professional availability variations, impacting HRA implementation globally (Strohmeier et al. 2022). Future research should explore these variations, offering a more granular and comprehensive analysis of HRA challenges and mitigation strategies within specific organisational contexts. This approach will provide valuable insights for organisations aiming to harness the power of HRA while addressing challenges pertinent to their unique circumstances.

Therefore, three future research directions are recommended. Firstly, conducting case studies on successful HRA implementations is proposed, with a primary focus on larger corporations. These case studies offer comprehensive insights into these large enterprises' historical evolution and present internal HR dynamics. Such investigations will provide valuable benchmarks and insights, especially beneficial for SMEs (Shet et al. 2021). By delving into the experiences, achievements, and hurdles

related to HRA, these case studies offer essential best practices and valuable lessons for a broad spectrum of entities and catalyse proactive adoption of HRA among SMEs (Bechter et al. 2022). Secondly, researchers may consider conducting cross-industry case studies to explore the application of HRA in different sectors. Various industries often face unique challenges and opportunities, potentially leading to differences in HRA implementation strategies and outcomes. By comparing cases from diverse industries, more precise guidance can be offered to different types of organisations, assisting them in addressing HRA challenges and opportunities more effectively (Garg et al. 2022). Lastly, future research should emphasise the ethical and legal implications of HRA, particularly concerning data privacy and security issues. With the widespread use of data in HRA, questions surrounding the lawful and compliant handling and protection of employee data have become paramount (Falletta and Combs 2021). Future research can delve into the ethical challenges within HRA practices and study the legal requirements and standards for employee data privacy in different countries or regions, aiding organisations in formulating HRA strategies and policies that align with legal regulations (Lee and Lee 2024; Wirges and Neyer 2022). These research directions will contribute to a more comprehensive understanding of the challenges and trends in HRA.

7 Conclusion

Human beings cannot exclusively rely on statistics and data to resolve all organisational challenges; HRA is not a panacea. However, the importance of HRA is rapidly growing in the information age, a trend that cannot be ignored by any means. HRA offers a valuable asset, providing scientific foundations and strategic insights for organisations to address the ever-evolving market challenges and talent needs. Contemporary HRA practices and applications confront multiple and substantial challenges, yet these challenges are manageable. By addressing the issues related to data governance, skills, and organisational challenges, the potential of HRA could be harnessed to identify, nurture, and retain talent, thus ensuring a sustained competitive advantage. The path of future research should continue to explore the multifaceted applications of HRA in diverse organisational contexts, propelling the development of data-driven HRM and enabling organisations to implement more intelligent and intricate HRM practices through HRA.

Appendix 1: Summary of 101 articles

No.	Study	Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
1	Harris J.G.; Craig E.; Light D.A	Talent and analytics: new approaches, higher ROI	2011	✓	✓			✓	✓	✓			
2	Raging debates in HR analytics		2012	✓	✓					✓	✓		
3	Dulebohn J.H.; Johnson R.D	Human resource metrics and decision support: A classification framework	2013					✓			✓		
4	Cascio W.; Boudreau J	HR strategy: optimising risks, optimising rewards	2014	✓	✓			✓	✓			✓	
5	Ulrich D.; Dulebohn J.H	Are we there yet? What's next for HR?	2015	✓	✓			✓	✓		✓		
6	Rasmussen T.; Ulrich D	Learning from practice: How HR analytics avoids being a management fad	2015	✓			✓			✓			

No.	Study	Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
7	Lal P		Transforming hr in the digital era: Workforce analytics can move people specialists to the center of decision-making	2015	✓	✓	✓	✓					
8	Angrave D.; Chari-wood A.; Kirkpatrick I.; Lawrence M.; Stuart M		HR and analytics: Why HR is set to fail the big data challenge	2016							✓		
9	King K.G		Data Analytics in Human Resources: A Case Study and Critical Review	2016	✓			✓	✓				✓
10	Khan S.A.; Tang J		The paradox of human resource analytics: Being mindful of employees	2016	✓	✓	✓				✓		
11	Chaturvedi V		Talent Analytics as an Indispensable Tool and an Emerging Facet of HR for Organization Building	2016	✓			✓	✓	✓			

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
12	Patre S	Six thinking hats approach to HR analytics	2016	✓		✓		✓		✓		
13	Marler J.H.; Boudreau J.W	An evidence-based review of HR Analytics	2017	✓	✓			✓		✓	✓	
14	Shah N.; Irani Z.; Sharif A.M	Big data in an HR context: Exploring organisational change readiness, employee attitudes and behaviours	2017	✓	✓			✓		✓		
15	van den Heuvel S.; Bondarouk T	The rise (and fall?) of HR analytics: A study into the future application, value, structure, and system support	2017	✓	✓			✓		✓		
16	Boudreau J.; Cascio W	Human capital analytics: why are we not there?	2017			✓				✓		✓
17	van der Togt J.; Rasmussen T.H	Toward evidence-based HR	2017					✓		✓	✓	

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
18	Andersen M.K	Human capital analytics: the winding road	2017			✓	✓	✓		✓		
19	Martin-Rios C.; Pougnet S.; Noga-reda A.M	Teaching HRM in contemporary hospitality management: a case study drawing on HR analytics and big data analysis	2017	✓	✓	✓	✓	✓		✓	✓	
20	Alamelu R.; Nalini R.; Cresenta Shakila Motha L.; Armudha R.; Bowiya S	Adoption factors impacting Human Resource analytics among employees	2017	✓	✓	✓	✓	✓		✓	✓	
21	Gobbie M.M	The Datification of Human Resources	2017	✓	✓	✓				✓		
22		HR analytics: A study into the current state of HR analytics and predictions for its future	2017	✓	✓	✓	✓	✓		✓		

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
23		Barriers to effective use of human capital analytics: Focus and strategy are needed to make the data useful	2017	✓		✓	✓	✓	✓	✓	✓	✓
24	Levenson A	Using workforce analytics to improve strategy execution	2018	✓	✓	✓				✓		
25	Vargas R.; Yurova Y.V.; Ruppel C.P.; Tworoger L.C.; Greenwood R	Individual adoption of HR analytics: a fine grained view of the early stages leading to adoption	2018				✓	✓		✓		
26	Schiemann W.A.; Seibert J.H.; Blankenship M.H	Putting human capital analytics to work: Predicting and driving business success	2018	✓	✓	✓	✓	✓		✓	✓	

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27	Wang L.; Cotton R	Beyond Money-ball to social capital inside and out: The value of differentiated workforce experience ties to performance	2018									✓
28	Simón C.; Ferreiro E	Workforce analytics: A case study of scholar-practitioner collaboration	2018	✓	✓	✓	✓	✓		✓		
29	Calvard, Thomas Stephen; Jeske, Debora	Developing human resource data risk management in the age of big data	2018	✓			✓	✓			✓	
30	Rombaut E.; Guerry M.-A	Predicting voluntary turnover through human resources database analysis	2018	✓	✓	✓	✓	✓	✓			
31	Francis H.; Baum T	HR transformation within the hotel industry: building capacity for change	2018									✓

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32	Claus L		HR disruption—Time already to reinvent talent management	2019	✓	✓		✓	✓		✓		
33	Wang N.; Katsamakas E		A network data science approach to people analytics	2019			✓	✓		✓			
34	Hirsch P.B		Tinker, Tailor, Soldier, Spy	2019	✓		✓			✓			
35	Rathi Meena M.; Parimalarani G		Human capital analytics: A game changer for HR professionals	2019	✓	✓	✓	✓			✓		
36	Ziebell, Robert-Christian; Alborns Garrigos, Jose; Schoeneberg, Klaus-Peter; Perello Marin, Maria Rosario		e-HRM in a Cloud Environment Implementation and its Adoption: A Literature Review	2019									
37	Posthumus J.; G.; Santora J.C		BozerThe use of market analytics in the recruitment of high-potentials in the pharmaceutical industry	2019	✓		✓	✓	✓			✓	

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
38	Newman D.T.; N.J.; Harmon D.J	Fast When eliminating bias isn't fair: Algorithmic reductionism and procedural justice in human resource decisions	2020	✓		✓						
39	Gal U.; Jensen T.B.; Stein M.-K	Breaking the vicious cycle of algorithmic management: A virtue ethics approach to people analytics	2020	✓		✓						
40	Hamilton R.H.; Sodemam W.A	The questions we ask: Opportunities and challenges for using big data analytics to strategically manage human capital resources	2020	✓	✓		✓					
41	Pessach D.; Singer G.; Avrahami D.; Chalutz Ben-Gal H.; Shmueli E.; Ben-Gal I	Employee recruitment: A prescriptive analytics approach via machine learning and mathematical programming	2020	✓	✓	✓			✓			✓

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
42	Peeters T.; Paauwe J.; Van De Voorde K	People analytics developing a framework	2020	✓	✓	✓						
43	Dahlbom P.; Siikane N.; Sajasalo P.; Jarvenpää M	Big data and HR analytics in the digital era	2020			✓		✓	✓			
44	Greasley, Kay; Thomas, Pete	HR analytics: The onto-epistemology and politics of metricised HRM	2020					✓		✓		
45	Zeidan S.; Itani N	HR analytics and organisational effectiveness	2020					✓			✓	
46	Ryan J.C	Retaining, resigning and firing: bibliometrics as a people analytics tool for examining research performance outcomes and faculty turnover	2020	✓	✓	✓		✓	✓		✓	
47	Jain P.; Jain P	Understanding the concept of HR analytics	2020					✓			✓	✓

No.	Study	Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
48		Polyakova A.; Kolmakov V.; Pokamestov I	Data-driven HR analytics in a quality management system	2020	✓	✓	✓		✓		✓		
49		Fernandez V.; Gallardo-Gallardo E	Tackling the HR digitalisation challenge: key factors and barriers to HR analytics adoption	2021	✓	✓			✓		✓	✓	
50		Minbaeva D	Disrupted HR?	2021		✓		✓			✓		✓
51		Kim S.; Wang Y.; Boon C	Sixty years of research on technology and human resource management: Looking back and looking forward	2021					✓				
52		Garcia-Arroyo J.; Osca A	Big data contributions to human resource management: a systematic review	2021	✓	✓	✓	✓	✓		✓		

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
53	Srivastava P.R.; Eachempati P	Intelligent Employee Retention System for Attrition Rate Analysis and Churn Prediction: An Ensemble Machine Learning and Multi-Criteria Decision-Making Approach	2021	✓	✓	✓	✓		✓		✓
54	Shet S.V.; Poddar T.; Wambasa Samuel F.; Dwivedi Y.K	Examining the determinants of successful adoption of data analytics in human resource management – A framework for implications	2021	✓		✓	✓		✓		
55	Zhou, Yu; Liu, Guangjian; Chang, Xiaoxi; Wang, Lijun	The impact of HRM2021 digitalisation on firm performance: investigating three-way interactions	2021	✓		✓	✓		✓		✓

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling/technical issues	Lack of analytical skills	Lack of analytical competency change	Organisational resistance to change	Budget constraints	Lack of decision-maker support
56	Falletta S.V.; Combs W.L	The HR analytics cycle: a seven-step process for building evidence-based and ethical HR analytics capabilities	2021	✓	✓		✓	✓	✓	✓		✓
57	McCartney S.; Fu	NBridging the gap: why, how and when HR analytics can impact organisational performance	2021		✓	✓		✓		✓		
58	Karwehl L.J.; Kaufeld S	Traditional and new ways in competence management: Application of HR analytics in competence management; [Traditionelle und neue Wege im Kompetenzmanagement: Anwendung von HR Analytics im Kompetenzmanagement]	2021	✓		✓		✓			✓	

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
59	Ellmer M.; Reichel A	Staying close to business: the role of epistemic alignment in rendering HR analytics outputs relevant to decision-makers	2021	✓	✓		✓			✓		✓
60	Brédart X.; Séverin E.; Veganzones D	Human resources and corporate failure prediction modelling: Evidence from Belgium	2021		✓	✓			✓			
61	Lawrance N.; Petrides G.; Guerry M.-A	Predicting employee absenteeism for cost effective interventions	2021				✓					

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
62	Michelotti M.; McColl R.; Pungeva-Michelotti P.; Clarke R.; McNamara T	The effects of medium and sequence on personality trait assessments in face-to-face and videoconference selection interviews: Implications for HR analytics	2021	✓	✓	✓	✓	✓			✓	
63	Speer A.B	Empirical attrition modelling and discrimination: Balancing validity and group differences	2021	✓	✓	✓	✓	✓	✓			
64	Hota J	Framework of Challenges Affecting Adoption of People Analytics in India Using ISM and MICMAC Analysis	2021									

No.	Study	Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
65	Margherita A		Human resources analytics: A systematisation of research topics and directions for future research	2022	✓	✓		✓	✓		✓	✓	✓
66	Garg, Swati; Shuchi; Kar, Arpan Kumar; Mani, Mauricio	Simha, A review of machine learning applications in human resource management	2022	✓	✓	✓				✓			
67	Tursunbayeva, Aizhan; Pagliari, Claudia; Di Lauro, Stefano; Antonelli, Gilda	The ethics of people analytics: risks, opportunities and recommendations	2022	✓	✓	✓			✓	✓			✓
68	Qamar, Yusra; Samad, Taab Ahmad	Human resource analytics: a review and bibliometric analysis	2022	✓	✓	✓				✓			
69	Chatterjee S.; Chaudhuri R.; Vrontis D.; Siamou E	Examining the dark side of human resource analytics: an empirical investigation using the privacy calculus approach	2022	✓	✓	✓							

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
70	McCartney S.; Fu	NPromise versus reality: a systematic review of the ongoing debates in people analytics	2022	✓	✓	✓	✓	✓		✓		
71	Belizón M.J.; Kieran S	Human resources analytics: A legitimacy process	2022		✓	✓		✓		✓		✓
72	Hamilton, R. H.; Davison, H. Kristl	Legal and Ethical Challenges for HR in Machine Learning	2022	✓		✓						
73	Edwards M.R.; Charlwood A.; Guenole N.; Marler J	HR analytics: An emerging field finding its place in the world alongside simulating ethical challenges	2022	✓	✓			✓		✓		
74	Bartram T.; Cooke F.L	Celebrating the 60th anniversary of the Asia Pacific Journal of Human Resources: what has been achieved and what more can be done	2022	✓	✓	✓		✓		✓		✓

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
75	Jörden N.M.; Sage D.; Trusson C	'It's so fake': Identity performances and cynicism within a people analytics team	2022	✓	✓	✓						
76	Saputra A.; Wang G.; Zhang J.Z.; Behl A	The framework of talent analytics using big data	2022	✓	✓	✓	✓					
77	Cayrat C.; Boxall P	Exploring the phenomenon of HR analytics: a study of challenges, risks and impacts in 40 large companies	2022	✓	✓	✓	✓	✓	✓	✓		
78	Saxena M.; Bagga T.; Gupta S.; Kaushik N	Exploring Common Method Variance in Analytics Research in the Indian Context: A Comparative Study with Known Techniques	2022	✓	✓	✓	✓	✓	✓	✓		

No.	Study	Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
79	Shet S.; Nair B		Quality of hire: expanding the multi-level fit employee selection using machine learning	2022	✓	✓		✓	✓				✓
80	Bechter B.; Brandl B.; Lehr A		The role of the capability, opportunity, and motivation of firms for using human resource analytics to monitor employee performance: A multi-level analysis of the organisational, market, and country context	2022	✓		✓		✓		✓		
81	Arora M.; Mittal A.; Singh S	Prakash A.; Mittal A.; Singh S	Moderating role of resistance to change in the actual adoption of HR analytics in the Indian banking and financial services industry	2022	✓	✓		✓			✓	✓	

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
82	Ontrup G.; Schempp P.S.; Kluge A	Choosing the right (HR) metrics: digital data for capturing team proactivity and determinants of content validity	2022	✓	✓		✓	✓		✓		✓
83	Ekka S.; Singh P	Predicting HR Professionals' Adoption of HR Analytics: An Extension of UTAUT Model	2022		✓		✓			✓	✓	
84	Wang, Lijun; Zhou, Yu; Zheng, Guoyang	Linking Digital HRM Practices with HRM Effectiveness: The Moderate Role of HRM Capability Maturity from the Adaptive Structuration Perspective	2022					✓				
85	Birnbaum D.; Somers M	Past as prologue: Taylorism, the new scientific management and managing human capital	2022	✓								✓

No.	Study	Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
86	Hastuti R.; Timming A.R		Can HRM predict mental health crises? Using HR analytics to unpack the link between employment and suicidal thoughts and behaviours	2022	✓	✓	✓	✓	✓	✓	✓		
87	Wirges F.; Neyer A.-K		Towards a process-oriented understanding of HR analytics: implementation and application	2022	✓	✓	✓	✓	✓	✓	✓	✓	✓
88	Arora M.; Prakash A.; Mittal A.; Singh S		Examining the slow acceptance of HR analytics in the Indian engineering and construction industry: a SEM-ANN-based approach	2022	✓	✓	✓	✓	✓	✓	✓	✓	✓
89	Strohmeier S.; Collet J.; Kabst R		(How) do advanced data and analyses enable HR analytics success? A neo-configurational analysis	2022	✓	✓	✓	✓	✓	✓	✓	✓	✓

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
90	Avrahami D.; Pes-sach D.; Singer G.; Chalutz Ben-Gal H	A human resources analytics and machine-learning examination of turnover: implications for theory and practice	2022	✓	✓	✓	✓	✓		✓		
91	Ameer R.; Garg P	Factors Impacting Adoption of Human Resource Analytics among HR Professionals in India	2022	✓	✓		✓	✓		✓	✓	
92	Pariona-Cabrera P.; Cavanagh J.; Halvorsen B	Examining the need for HR analytics to better manage and mitigate incidents of violence against nurses and personal care assistants in aged care	2022	✓	✓	✓	✓	✓		✓		
93	Dhankhar K.; Singh A	Employees' adoption of HR analytics – a theoretical framework based on career construction theory	2022	✓	✓	✓		✓		✓		

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
94	Cavanagh J.; Walker M.; Pariona-Cabrera P.; Bartram T.; Halvorsen B	Health services in Australia and the impact of antiquated rostering practices on medical scientists: a case for HR analytics and evidenced-based human resource management	2022	✓	✓	✓	✓	✓			✓	
95	Kashive N.; Khanna V.T	Emerging HR analytics role in a crisis: an analysis of LinkedIn data	2022	✓		✓		✓	✓	✓		
96	Pempokai S.; Vuthisoopon S.; Saengnoree A	THE RELATIONS BETWEEN TECHNOLOGY ADOPTION, HR COMPETENCIES, AND HR ANALYTICS OF LARGE-SIZE ENTERPRISES	2023					✓	✓			
97	Fu N.; Keegan A.; McCartney S	The duality of HR analysts' storytelling: Showcasing and curbing	2023	✓	✓							✓

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98	Böhmer N.; Schin- nenburg H	Critical exploration of AI-driven HRM to build up organisational capabilities	2023	✓	✓			✓	✓			
99	Ratnam D.S.; Devi V.R	Addressing impediments to HR analytics adoption: guide to HRD professionals	2023	✓	✓	✓		✓		✓		
100	Conte F.; Siano A	Data-driven human resource and data-driven talent management in internal and recruitment communication strategies: an empirical survey on Italian firms and insights for European context	2023	✓	✓	✓		✓		✓		
101	Verma S.; Rana N.; Meher J.R	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2023	✓	✓	✓		✓		✓		✓

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
102	Ratnam D.S.; Devi V.R	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓	✓	✓	✓	✓	✓	✓
103	Thakur S.J.; Bhatnagar J.; Farndale E.; Aeron P	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓	✓	✓	✓	✓	✓	✓
104	Rigamonti E.; Gastaldi L.; Corso M	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓	✓	✓	✓	✓	✓	✓
105	Rigamonti E.; Colaiacovo B.; Gastaldi L.; Corso M	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓	✓	✓	✓	✓	✓	✓

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
106	Rasheed M.H.; Khalid J.; Ali A.; Rasheed M.S.; Ali K	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓		✓	✓				✓
107	Abalos P.N.S.; Palaoag T.D	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓						✓
108	Heidemann A.; Hüter S.M.; Tekieli M	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓	✓					
109	Hüter S.M.; Errel C.; Heidemann A	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓			✓			

No.	Study Authors	Title	Year	Data Privacy and Security Concerns	Data Quality concerns	Data Fairness and Transparency Concerns	Data Modelling Issues	Lack of technical skills	Lack of analytical competency	Organisational resistance to change	Budget constraints	Lack of decision-maker support
110	Lee J.Y.; Lee Y	Identifying the enablers of HR digitalisation and HR analytics using ISM and MICMAC analysis	2024	✓	✓	✓						
			Total	73	76	44	36	77	25	65	32	19

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Declarations

Conflict of interest The authors declare that no funds, grants, or other support were received during the preparation of this manuscript. The authors have no relevant financial or non-financial interests to disclose.

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