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Working with robots: Trends and future directions

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ABSTRACT

Robots are taking on a prominent role in driving organizational evolution toward industrial revolutions. While research on the role of robots in human resource management (robot-HRM) is proliferating, the literature falls short in providing a state-of-the-art overview of the progress and ways forward for the field. Hence, this study aims to review and consolidate the extant literature on robot-HRM into a unified framework and provide pragmatic ways forward. To do so, this study conducts a framework-based systematic literature review by adopting the SPAR-4-SLR protocol to guide its assembling, arranging, and assessing of theories, contexts, characteristics, and methods (TCCM) of robot-HRM studies identified and retrieved from Scopus and Web of Science. In doing so, this study contributes a seminal overview of the research trends and ways forward for robot-HRM, as well as the implications for professionals to manage the embedding of robots and the interaction with employees in the workplace.

1. Introduction

In response to the intense competition in the business world and the catastrophe of the pandemic, many companies are forced to adapt to the new normal by adopting new and cutting-edge technologies to achieve high performance and competitive advantage (Allal-Chérif et al., 2021; Lim, 2021, 2023b). Among the many cutting-edge technologies, the adoption of robots powered by artificial intelligence (AI) is emerging in the workplace, whereby humans and robots work together, a trend that ushers in the era of Industry Revolution 5.0 (IR5.0), where humans and robots coexist and cooperate or collaborate in the workplace (Nichols, 2020).

In essence, a robot is a programmable machine that has the ability to sense and interact with its environment, carrying out tasks either partially or fully on its own (Nichols, 2020). The increasing use of robots includes not only industrial robots but also service robots (e.g., service agents), which is most prominently seen across service industries such as healthcare, logistics, hospitality, and tourism (Al-Razgan et al., 2016). Robots such as “Chloe”, “Pepper”, and “LoweBot” are some popular examples of integrating robots with humans in the workforce, thereby promoting the “socio-technical role” of human-robot collaboration in the workplace (Nichols, 2020).

The adoption of robotics is growing every year. According to Statista (2022a), the global robotics market is expected to exceed $13 billion by 2030. In fact, approximate 88% of global enterprises are planning to adopt robotics in their infrastructure, a scale that will accelerate business operations and reduce costs for short and long term (Chen et al., 2022). Such innovation also offers a myriad of potential advantages for human resource management (HRM). As robotics become more advanced and creative, human resource (HR) managers are increasingly seen investing in robots for workforce learning and skills training to strategically prepare for the future of work (Azam, 2023; Kate, 2020).

Looking back at the literature, robots play an important role in HRM functions, such as creating a more agile and effective process in assessing

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applicants (Bondarouk et al., 2017; McKinsey, 2017), recruiting employees (Balcioğlu and Artar, 2024; Cooke et al., 2019), assessing employee performance (Abraham et al., 2019), and predicting employee turnover (Saradhi and Palshikar, 2011), thereby improving management decisions (Liboni et al., 2019). The successful implementation of robotics in the workplace increases organizational competitiveness, especially in terms of cost and time savings (McKinsey, 2022). Therefore, it is unsurprising that the introduction and use of robots in HRM practices have quickly become a mainstay of technological change and innovation globally in the transformation toward IR 5.0 (Seeck and Diehl, 2017).

Apart from that, a new stream of research has begun to emerge in HRM, where scholars have called for a deeper understanding of the factors that drive employees' resistance toward working with robots in the workplace. Drawing from extant studies, the negative perceptions could be attributed to workforce reduction (McKinsey, 2022), negative attitudes and lack of trust in automation and smart technologies (Raisch and Krakowski, 2021), reduced organizational commitment, and lower productivity (Brougham and Haar, 2018), among others. In the same vein, several studies have also shown that employees are reluctant to embrace robotics because they are afraid of losing their jobs (Nichols, 2020; Vatan and Dogan, 2021). Noteworthily, the fear of unemployment can increase psychological stress, leading to anxiety, lack of engagement and commitment, and even turnover, with the subsequent possibility of a terrible financial situation. According to the McKinsey Global Institute, robots and other smart technologies will replace nearly 69% of the current workload in the workforce by 2030 (McKinsey, 2022). All this points to the fact that while robotics can bring advantages to companies and employees by increasing the efficiency and flexibility of production and services, it also poses critical challenges (e.g., expensive capital investment to acquire, embed, and maintain robots; upskilling employees to work with robots; increase unemployment rate due to robot replacement).

Although studies of robots in HRM (hereafter robot-HRM) are emerging and likely to grow exponentially in the coming years, especially in the post-COVID pandemic era, their findings remain preliminary and fragmented. The question of whether the integration of technology and HRM can serve as a strategic partnership has not been fully addressed due to the lack of theory-driven and evidence-based research findings (Strohmeier, 2007). While several researchers have reviewed research on AI, robotics, and advanced technologies in HRM (Ballestar et al., 2022; Kaushal et al., 2021), there is no unified framework that can be used to predict the adoption and non-adoption of robotics in the workplace from an individual and organizational perspective (i.e., robot-HRM). This study responds to the call by Vrontis et al. (2022) that the use of robots will replace certain human jobs, and there is a need to address the reactions in HR practice that technology brings to the various participants in the entire HRM hierarchy. Notably, no systematic literature review, to date, has provided a comprehensive review of the theories, contexts, characteristics, and methods in robot-HRM studies, thereby limiting understanding on the unique peculiarities of robot-HRM and the ways in which this emergent phenomenon could be rigorously studied. The lack of a unified framework that comprehensively explains these aspects of robot-HRM therefore warrants a unifying effort, which can be undertaken through a framework-based systematic literature review (Lim et al., 2022). Therefore, this study aims to review and consolidate the extant literature on robot-HRM into a unified framework and provide pragmatic ways forward to advance the field. In doing so, this study endeavors to answer three research questions (RQ):

RQ1. What do we know about robotics implementation for HRM in the workplace?

RQ2. How do we know about robotics implementation for HRM in the workplace?

RQ3. Where should research go with robotics for HRM in the workplace?

Building on the foundation established in the preceding discussion, this study takes significant strides beyond the limitations of previous inquiries such as those related to AI-driven technologies within HRM. In particular, prior reviews often confined their analyses to thematic aggregations, offering broad, macro-level insights without delving into the complex interactions and peculiarities at individual and organizational tiers (Prikshat et al., 2023; Qamar et al., 2021; Vrontis et al., 2022). This study endeavors to demystify the complex dynamics of robot-HRM, emphasizing the diverse challenges, opportunities, and outcomes robots pose across the spectrum of HRM strategies and operations. Adopting such a lens, this study not only refreshes the academic conversation with an up-to-date synthesis of existing scholarship but also unveils the transformative potential robots hold in navigating specific HRM challenges. Moreover, this study leverages the TCCM framework—a schema that encapsulates theories, contexts, characteristics, and methods—to orchestrate a structured and comprehensive literature review (Paul and Rosado-Serrano, 2019). This methodological approach is instrumental in painting a detailed portrait of robot-HRM research, shedding light on the relationships among antecedents, phenomena, and outcomes associated with the deployment of robots in HRM practices, as well as the theoretical, contextual, and methodological nuances that have shaped the state of robot-HRM research. More importantly, in a significant departure from existing reviews, this study proposes an ambitious research agenda that ventures deep into the theoretical foundations, contextual particulars, and methodological variations observed in the field. These insights not only illuminate the current research landscape but also carve out new avenues for inquiry, pinpointing critical gaps and suggesting fertile grounds for future exploration in robot-HRM. Through this endeavor, this study aspires to catalyze a more rigorous, theory-driven discourse on robot-HRM, thereby offering a robust platform for advancing understanding of the role and impact of robotics in HRM.

The remainder of this article is organized as follows. Section two offers a comprehensive overview of recent work, situating our study within the existing literature. Section three clarifies the review methodology. Section four conveys the findings pertaining to *what do we know* and *how do we know* about robotics implementation for HRM in the workplace, wherein the insights on characteristics contribute to answering the former, and the theoretical, contextual, and methodological insights contribute to answering the latter in line with the structure stipulated by the organizing framework adopted for this review (i.e., the TCCM framework). Section five speaks to the research question of *where should research go with robotics for HRM in the workplace* through the gaps identified and the agenda proposed for future research in the field. Section six explains the academic and practical implications of this review, whereas section seven concludes the article.

2. Conceptual background

2.1. Robotics in HRM

In the evolving landscape of HRM, the incursion of AI and digital technologies has precipitated a paradigm shift, redefining the contours of traditional HRM practices (Islam et al., 2023). This technological renaissance, exemplified by Tesla's unveiling of the Optimus Gen-2 humanoid robot in December 2023, underscores the progressive trajectory of robotics in HRM. Elon Musk's assertion that the robot is engineered to undertake tasks avoided by humans highlights the transformative potential of robotics to augment and, in certain instances, replace human labor in roles demanding manual dexterity. The humanoid design of the Optimus Gen-2, mirroring human proportions, signals a shift where robots are not merely supporting tools but integral components of HRM processes, potentially transforming task execution and enhancing operational efficiencies. This technological evolution invites a recalibration of HRM, necessitating a synthesis of novel theoretical frameworks and actionable strategies to navigate the emergent challenges and opportunities.

The academic discourse, as reflected in contemporary research, illuminates the multifaceted contributions of robotics to HRM. For instance, the automation of recruitment processes through sophisticated algorithms for resume screening and data analytics has markedly optimized candidate selection, aligning talent acquisition with organizational strategic imperatives while simultaneously alleviating the administrative burden on HR professionals (Balcioğlu and Artar, 2024; Cooke et al., 2019; Nichols, 2020). Furthermore, the deployment of robotics has been instrumental in mitigating human errors and biases in decision-making, thereby fostering a more equitable and efficient HRM ecosystem (Flechsig et al., 2022; Obashi and Kimura, 2021).

Despite these advancements, the integration of AI and robotics within HRM is met with a degree of skepticism from certain quarters (Acemoglu and Restrepo, 2020; Rampersad, 2020). Criticisms hinge on the substantial capital outlay requisite for the acquisition, integration, and upkeep of robotic systems, the imperative for workforce reskilling to ensure harmonious human-robot collaboration, and concerns over rising unemployment rates driven by automation (Brougham and Haar, 2018; Chowdhury et al., 2022; Kate, 2020; Raisch and Krakowski, 2021; Seeck and Diehl, 2017). In this context, robots emerge not merely as technological novelties but as pivotal elements capable of catalyzing a radical overhaul of conventional HRM paradigms, presenting both formidable challenges and unprecedented opportunities for HR practitioners (Nichols, 2020).

2.2. Robots and employees

The intersection of robotics and employee engagement within HRM presents a complex landscape of challenges and opportunities. While the scholarly focus has extensively mapped the terrain of robotics on talent management dynamics (Cristina and Corneliu, 2021; Gupta et al., 2018), and their role in engendering a demand for novel skillsets (Nichols, 2020; Cai et al., 2020; Chuang, 2024), the pervasive march of automation heralds a paradigm shift in traditional employment. The advent of robotics is recalibrating the demand for certain skillsets, heralding a potential displacement of manual labor and roles associated with outdated skills (Del Giudice et al., 2023). This technological transformation not only signals a reconfiguration of job roles but also stirs existential anxieties over job security, leading to a noticeable resistance to robotic integration among the workforce (Acemoglu and Restrepo, 2020).

In environments where collaboration with robots transitions from optional to imperative, robots are reconceptualized from passive tools to dynamic "team partners," an evolution that enriches the fabric of job functions with layers of complexity, necessitating a heightened degree of interoperability between human and machine (Evjemo et al., 2020; Ivanov and Webster, 2019; Seeber et al., 2020). The orchestration of such symbiotic relationships extends beyond mere functional interactions by redefining the essence of work itself and infusing it with new meanings and possibilities (Smids et al., 2020).

The discourse on HRM underscores the criticality of optimizing human interactions and collaborations, where cognitive biases, emotional undercurrents, and personality divergences are recognized as pivotal influencers of team dynamics' efficacy (Smids et al., 2020). The fusion of robotic technologies into these human-centric ecosystems introduces a layer of complexity, as employees grapple with the psychological duress of assimilating into an increasingly automated workspace. This adaptation stress can lead to attrition, imposing financial and operational strains on individuals and organizations alike (De Obesso et al., 2023). Therefore, the confluence of robotics with human labor is not merely a technical evolution but a transformative shift that requires a strategic and empathetic response from HR leadership.

2.3. Gaps and opportunities

The examination of robot-HRM has illuminated the transformative impact that robotics integration exerts on HRM, spotlighting both the diverse benefits and the associated challenges. While the infusion of robotics within key HRM functionalities—such as recruitment, assessment, training, and development—has garnered considerable attention, the dynamics of employee-robot interactions and their broader implications are increasingly under scrutiny. Despite these advances, a holistic comprehension of robotics' augmentation of HRM practices remains an elusive frontier, with existing literature yet to coalesce around a robust, unified analytical framework that delineates the multifaceted role of robotics within HRM at both micro and macro levels (McKinsey, 2022; Kaushal et al., 2021; McKinsey, 2022).

Additionally, the current body of HRM research has stopped short of exhaustively mapping the influence of robotics across the gamut of HR practices (Pereira et al., 2023; Voegtlin and Greenwood, 2016), which this study shows to encompass human resource planning, training and development, employee and labor relations, appraisal and motivation, recruitment and selection, and health, safety, and well-being. A deeper dive into the utilization of robotics within these domains not only sheds light on the tangible outcomes and efficiencies achieved but also opens up avenues for future exploration.

Against this backdrop, the present study seeks to bridge these gaps by synthesizing existing robot-HRM research through a structured framework-based systematic literature review. In particular, this study endeavors to craft a comprehensive and scalable research agenda that not only encapsulates the current state of the field but also charts a pragmatic path forward, propelling the discourse into new dimensions of inquiry and application. This integrative approach promises to enrich understanding of robot-HRM, offering valuable insights into leveraging robotic technologies for enhancing HRM efficacy and strategizing for future challenges and opportunities in line with the evolving future of work and workforce revolution (Lim, 2023a).

3. Methodology

Systematic literature review is a scientific product emerging out of a rigorous methodology to take stock of existing knowledge, locate knowledge gaps, and serve as a springboard for future research to advance knowledge in the field (Donthu et al., 2021; Lim et al., 2022; Mukherjee et al., 2022a). Systematic literature review, which has been widely published in recent times (Bindra et al., 2022; Kolagar et al., 2022; Kumar et al., 2022; Marinković et al., 2022; Mukherjee et al., 2022b), can be classified into domain-based reviews, theory-based reviews, and method-based reviews (Palmatier et al., 2018). A domain-based review using a structured framework (i.e., the TCCM framework) was chosen to answer the proposed research questions related to robot-HRM, as this review approach enables the systematic organization of the literature into a unified framework and thus a structured understanding of the field. As suggested by Paul et al. (2021), framework-based reviews are often more useful and influential than other types of review. To ensure that the review is transparent and replicable, a review protocol was adopted—namely the Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) protocol by Paul et al. (2021). Specifically, the SPAR-4-SLR protocol offers a rigorous, transparent, and logical flow to justify the review decisions undertaken as well as to deliver state-of-the-art insights of the field (Luna-Cortés et al., 2022; Tsiotsou and Boukis, 2022). The SPAR-4-SLR protocol is illustrated in Fig. 1 and the resulting framework from the review is presented in Fig. 2.

3.1. Framework-based review

This study uses the TCCM framework developed by Paul and Rosado-Serrano (2019). Past scholars suggest that reviews based on the TCCM

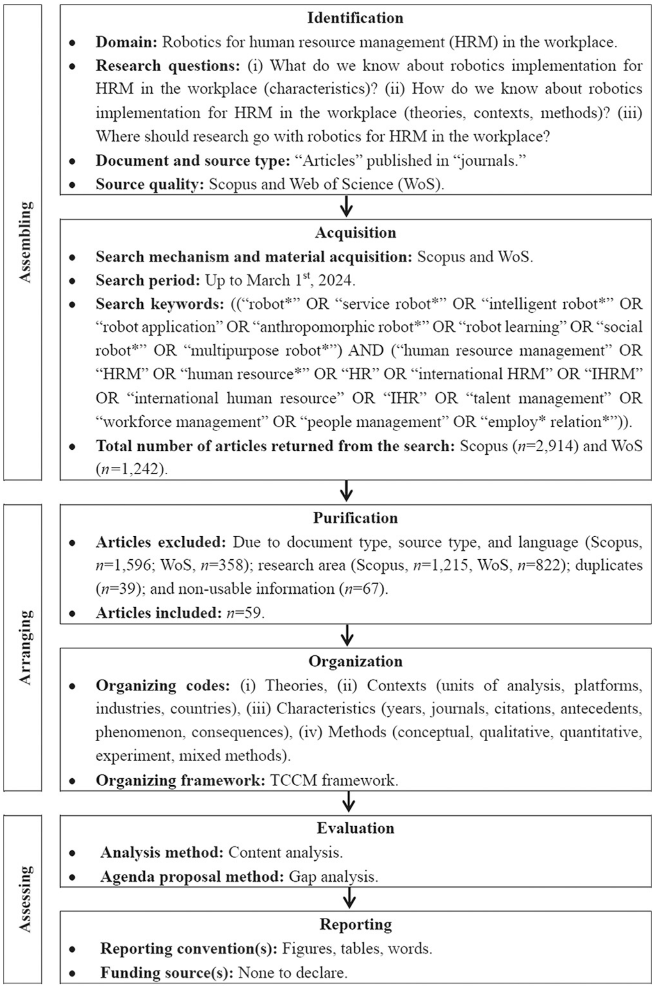

Fig. 1. The SPAR-4-SLR protocol adapted from Paul et al. (2021).

framework offer an organized structure and provide the highest level of clarity and coverage, producing more insightful and impactful results (Paul et al., 2021). Specifically, the TCCM framework contributes to this study's critical assessment of the theoretical foundations (T), characteristics (C), contextual peculiarities (C), and methodological matters (M) of robot-HRM research.

3.2. Review protocol

The SPAR-4-SLR protocol is a review protocol that comprises of three stages and six sub-stage that flow sequentially—namely (i) *assembling*, which consists of *identification* and *acquisition* of robot-HRM literature; (ii) *arranging*, which consists of *purification* and *organization* of retrieved robot-HRM literature; and (iii) *assessing*, which consists of *evaluating* and *reporting* of findings relating to robot-HRM literature.

3.2.1. Assembling

The *assembling* stage is made up of two sub-stages: *identification and acquisition*.

The sub-stage of *identification* involves defining the domain, research question, document and source type, and source quality. In this study, the review *domain* is robotics for HRM in the workplace, while the *research questions* pertain to: (i) What do we know about robotics implementation for HRM in the workplace (characteristics), (ii) How do we know about robotics implementation for HRM in the workplace (theories, contexts, methods), and (iii) Where should research go with robotics for HRM in the workplace. The *document and source type* is focused on research "articles" published in "journals." In contrast, other publications such as books, book chapters, conference papers, dissertations or theses, market reports, news reports, white papers or working papers, editorials, and review papers were excluded as they do not receive the same level of exploratory and peer scrutiny as in the case of research articles published in journals (Paul et al., 2021). The *source quality* was determined by research articles inclusion in Scopus and the Web of Science (WoS), which represent high quality scientific databases with stringent criteria for inclusion while serving as the search engines for the present review, thereby providing greater efficiency between search and quality check (Akbari et al., 2022; Budler et al., 2021; Soga et al., 2022).

The sub-stage of *acquisition* includes making decisions regarding *search mechanism and material acquisition*, in this case, Scopus and WoS. The *search period* for relevant research articles was set up to March 1st, 2024, which was the date of the search. The *search keywords* were related to robot and human resource management in the "article title, abstract, or keywords" search field on Scopus and WoS. Specifically, in line with Vrontis et al. (2022), several alternative keywords were combined with Boolean operators—i.e., "OR" & "AND"—and were used to search for

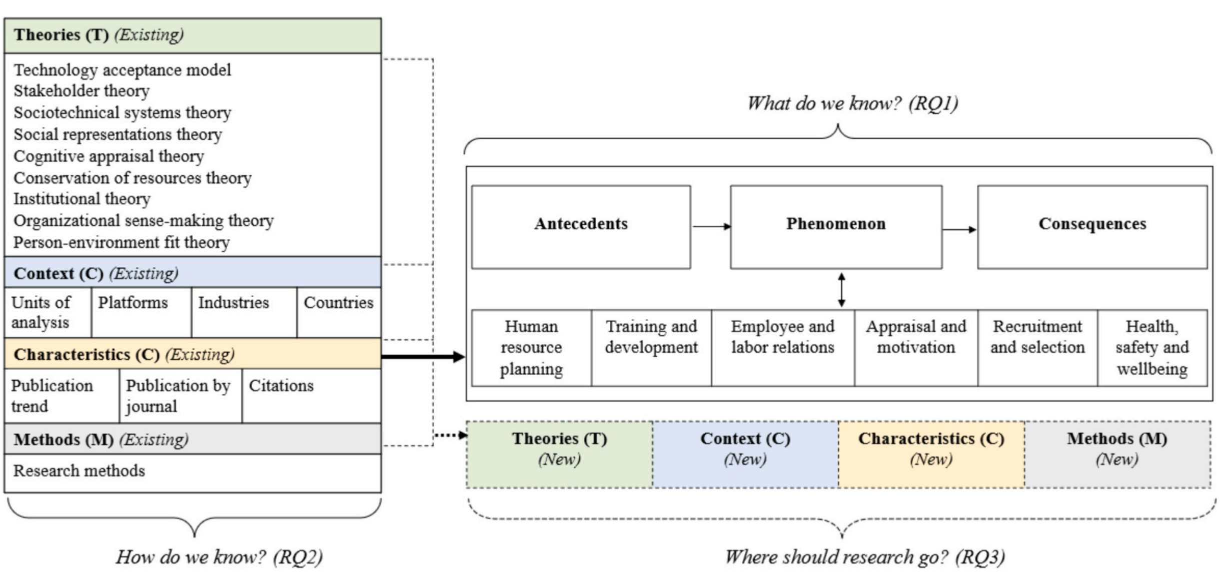

Fig. 2. The TCCM framework adapted from Paul and Rosado-Serrano (2019) and Lim et al. (2021).

relevant research articles. The search string was set as follows: ((“robot*” OR “service robot*” OR “intelligent robot*” OR “robot application” OR “anthropomorphic robot*” OR “robot learning” OR “social robot*” OR “multipurpose robot*”) AND (“human resource management” OR “HRM” OR “human resource*” OR “HR” OR “international HRM” OR “IHRM” OR “international human resource” OR “IHR” OR “talent management” OR “workforce management” OR “people management” OR “employ* relation*”)). In total, this search string resulted in a total of 4156 articles (i.e., Scopus: 2914; WoS: 1242).

3.2.2. Arranging

The *arranging* stage is made up of two sub-stages: *purification and organization*.

In the stage of *purification*, the initially identified research articles were screened for full-text relevance. Research articles that did not explicitly address the relationship between robotics and HRM were excluded, and only studies focused on robot-HRM in the areas of business and management, and published in “English” as a research “article” in “journal” were included. As a result, a total of 59 articles were included for further review (Appendix A).

In the stage of *organization*, all 59 research articles were coded and organized according to the TCCM framework, which included (i) theories, (ii) contexts (units of analysis, platforms, industries, countries), (iii) characteristics (years, journals, citations, antecedents, phenomenon, consequences), and (iv) methods (conceptual, qualitative, quantitative, experiment, mixed methods).

3.2.3. Assessing

The *assessing* stage is made up of two sub-stages: *evaluating and reporting*.

In the stage of *evaluation*, a content analysis was used to map and evaluate the (i) theories, (ii) contexts (units of analysis, platforms, industries, countries), (iii) characteristics (years, journals, citations, antecedents, phenomenon, consequences), and (iv) methods (conceptual, qualitative, quantitative, experiment, mixed methods). Gaps were identified in these areas using a gap analysis, which informs the curation of a future research agenda for robot-HRM.

In the stage of *reporting*, several methods including the use of figures, tables, and words were used to present the current insights of research in the domain of robot-HRM, while knowledge gaps and potential directions for future research were reported at the end of this article. No funding was sought nor received for this study.

4. Findings

4.1. What do we know about robotics implementation for HRM in the workplace (RQ1)

4.1.1. Article and yearly publication trends for robot-HRM research

The publication trends of robot-HRM research are presented in Fig. 3. The figure indicates that the volume of research in the field of robot-HRM is relatively limited despite the seminal work of Ayres and Miller (1982) being published in the early 1980s. Noteworthily, there is a recent rise of research interest in robot-HRM within the field of business and management, wherein the significant increase in research articles published between 2017 and 2024 (n = 52, 88.1 %) is a clear indication of the growing interest in the field. This is in contrast to the relatively low publication activity during the periods of 1982–1987 (n = 4, 6.8 %) and 2011–2016 (n = 2, 3.4 %).

4.1.2. Journal publication trends for robot-HRM research

The publication trends of robot-HRM research in journals are presented in Table 1. The table indicates that 59 research articles on robot-HRM were published across 47 peer-reviewed journals. The highest concentration of research articles was found in *Technology in Society* (n = 4), and *International Journal of Human Resource Management* (n = 3), followed by *International Journal of Contemporary Hospitality Management*, *European Journal of Training and Development*, *International Journal of Engineering Business Management, Journal of Business Research*, *Journal of Organizational Change Management*, *Problems and Perspectives in Management*, and *SA Journal of Human Resource Management* with two research articles each. The table also indicates that Elsevier and Emerald are the leading publishers with 10 peer-reviewed journals each. It is noteworthy that about 15 % of the journals were ranked “A*” by the ABDC. Of these, 9 % were rated as top-quality journals by the CABS (i.e., rated “4*”), thus indicating that robot-HRM research is welcomed at top-tier journals.

4.1.3. Most cited articles for robot-HRM research

Table 2 presents the top 10 most cited articles on robot-HRM. The

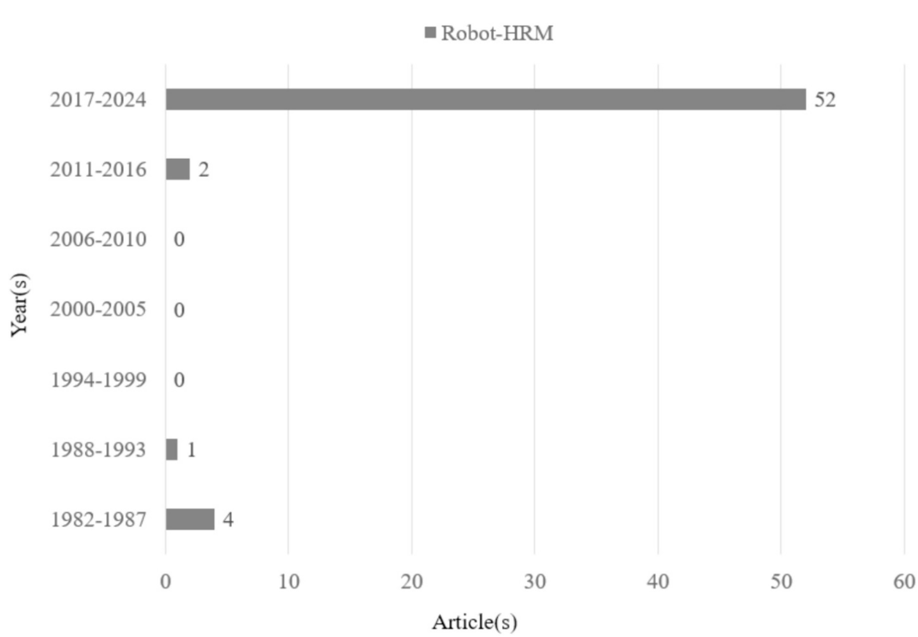

Fig. 3. Publication trend of robot-HRM research from 1982 to 2024.

Table 1
List of journals with robot-HRM research.

Journal title	Publisher name	ABDC ranking	CABS rating	TP
Technology in Society	Elsevier	C	N.R.	4
International Journal of Human Resource Management	Taylor & Francis	A	3	3
International Journal of Contemporary Hospitality Management	Emerald	A	3	2
European Journal of Training and Development	Emerald	C	1	2
International Journal of Engineering Business Management	SAGE	N.R.	1	2
Journal of Business Research	Elsevier	A	3	2
Journal of Organizational Change Management	Emerald	B	2	2
Problems and Perspectives in Management	Business Perspectives	N.R.	1	2
SA Journal of Human Resource Management	Open Journals Publishing AOSIS (Pty) Ltd	N.R.	1	2
Journal of Applied Psychology	American Psychological Association	A*	4*	1
Journal of Operations Management	Wiley-Blackwell	A*	4*	1
Management Science	INFORMS	A*	4*	1
Journal of Information Technology	SAGE	A*	4	1
Tourism Management	Elsevier	A*	4	1
Organization Studies	SAGE	A*	4	1
Human Resource Management Journal	Wiley-Blackwell	A	4*	1
Journal of Construction Engineering and Management	American Society of Civil Engineers	A*	2	1
Technological Forecasting and Social Change	Elsevier	A	3	1
Business Strategy and the Environment	Wiley-Blackwell	A	3	1
International Journal of Production Economics	Elsevier	A	3	1
International Journal of Production Research	Taylor & Francis	A	3	1
Journal of Purchasing and Supply Management	Elsevier	A	3	1
International Journal of Manpower	Emerald	A	2	1
Journal of Cleaner Production	Elsevier	A	2	1
Journal of Knowledge Management	Emerald	A	2	1
Journal of Management in Engineering	American Society of Civil Engineers	A	2	1
Systems Research and Behavioral Science	Wiley-Blackwell	A	2	1
Engineering, Construction and Architectural Management	Emerald	A	1	1
Journal of Hospitality and Tourism Management	Elsevier	A	1	1
Journal of Service Theory and Practice	Emerald	A	1	1
Business Horizons	Elsevier	B	2	1
Journal of Intellectual Capital	Emerald	B	2	1
Journal of Electronic Commerce in Organizations	IGI Global	B	1	1
Asian Economic Journal	Wiley-Blackwell	B	1	1
Journal of Hospitality and Tourism Technology	Emerald	B	1	1
European Management Review	Wiley-Blackwell	C	3	1
Journal of Management Development	Emerald	C	1	1
Human Systems Management	IOS Press	C	N.R.	1
Asia Pacific Journal of Human Resources	Wiley-Blackwell	N.R.	2	1
Journal of Information Technology Teaching Cases	SAGE	N.R.	1	1
Journal of Innovation and Knowledge	Elsevier	N.R.	1	1
Advances in Technology Innovation	Taiwan Association of Engineering and Technology Innovation	N.R.	N.R.	1
Organizacija	Sciendo	N.R.	N.R.	1
Autonomous Robots	Springer Nature	N.R.	N.R.	1
International Journal of Advanced Computer Science and Applications	Science and Information Organization	N.R.	N.R.	1
International Journal of Asian Business and Information Management	IGI Global	N.R.	N.R.	1
International Journal of Business Continuity and Risk Management	Inderscience	N.R.	N.R.	1

Notes: TP = total publications. N.R. = not rated. ABDC ranking = Journal ranked based on the Australian Business Deans Council 2022 Journal Quality List. CABS rating = Journal rating based on the Chartered Association of Business Schools 2021 Academic Journal Guide.

Table 2
Most cited publications.

TC	Title	Source	Year	CPY
272	Decision-making authority, team efficiency and human worker satisfaction in mixed human–robot teams	Gombolay et al.	2015	30.22
265	Robots and organization studies: Why robots might not want to steal your job	Fleming	2019	53.00
203	The robot revolution: Managerial and employment consequences for firms	Dixon et al.	2021	67.67
148	Progress toward the "factory of the future"	Rosenthal	1984	3.70
143	Knowledge, robots and productivity in SMEs: Explaining the second digital wave	Ballestar et al.	2020	35.75
142	Transformation toward smart factory system: Examining new job profiles and competencies	Jerman et al.	2020	35.50
138	Robotic process automation in purchasing and supply management: A multiple case study on potentials, barriers, and implementation	Flechsig et al.	2022	69.00
132	Employee perceptions on the implementation of robotic manufacturing technology	Chao and Kozlowski	1986	3.47
118	Artificial intelligence and human workers interaction at team level: A conceptual assessment of the challenges and potential HRM strategies	Arslan et al.	2022	59.00
109	How will service robots redefine leadership in hotel management? A Delphi approach	Xu et al.	2020	27.25

Notes: TC = total citations; CPY = citations per year.

table indicates that the highest cited article is Gombolay et al.'s (2015) article on human–robot teams, which took nine years to accumulate 272 citations, with an average of 30.22 citations per year. The second most cited article is Fleming (2019) with 265 citations (CPY: 53.00), followed by Dixon et al. (2021) with 203 citations (CPY: 67.67) and Rosenthal (1984) with 148 citations (CPY: 3.70).

4.1.4. Characteristics of robot-HRM research

The characteristics of robot-HRM research, as identified from 59 research articles, were structured based on the framework proposed by Wright and Snell (1991). The framework follows the logic of "antecedents-phenomenon-consequences," which is essential for facilitating a comprehensive and meaningful discussion of findings. This approach recognizes the unique technical aspects of each HRM function and enables a holistic understanding of how robots are utilized in the workplace, the factors influencing their implementation, and the outcomes resulting from human-robot collaborations. Adopting this framework, this study endeavors to provide a comprehensive overview of the characteristics of robot-HRM research, facilitating a deeper understanding of the dynamics and implications of integrating robots in HRM practices.

Antecedents refer to the determinants of the phenomenon (i.e., the *purposes* or *reasons* for robot-HRM), whereas *phenomenon* refers to *key features* and *practices* associated with the phenomenon (i.e., *outcomes* of robotics implementation in the workplace), and *consequences* refer to the *impact* of the phenomenon (i.e., *practical implications* from the using robotics for HRM in the workplace) (Pereira et al., 2023).

In the case of the present study, six main phenomenon are identified based on a review of robot-HRM research—i.e., (i) *human resource planning*, (ii) *training and development*, (iii) *employee and labor relations*, (iv) *appraisal and motivation*, (v) *recruitment and selection*, and (vi) *health, safety, and wellbeing*—and they are discussed next and summarized in Table 3 according to the logic of "antecedents-phenomenon-consequences."

4.1.4.1. Human resource planning. Nine research articles examined the practice of *human resource planning*. These articles were analyzed at the individual ($n = 6$) and organizational ($n = 3$) levels.

In terms of *antecedents*, the reasons for engaging in robotics for human resource planning include improving operational efficiency and quality (Šimek and Šperka, 2019; Nichols, 2020), improving task design and execution (Obashi and Kimura, 2021), upgrading workers' skills (Bhattacharyya and Nair, 2019), reducing employee burden and saving costs (Nichols, 2020; Flechsig et al., 2022), and enhancing interaction and collaboration of remote team members (Obashi and Kimura, 2021; Parvez et al., 2022).

In terms of *phenomenon*, the prominent outcomes and topics for study in relation to human resource planning using robotics include the ability of employees to cooperate (Nichols, 2020; Obashi and Kimura, 2021), employee productivity and efficiency (Šimek and Šperka, 2019; Nichols, 2020), employee turnover or unemployment (Obashi and Kimura, 2021), work agility (Šimek and Šperka, 2019), and complementarity between machines and HRM (Nichols, 2020; Obashi and Kimura, 2021).

In terms of *consequences*, relevant studies have shed light on the practical link between robotics and human resource planning. For instance, Nichols (2020) emphasize the importance for managers to grasp their employees' capabilities and their collaborative potential with robotics. Furthermore, they highlight the significance of exploring how new technologies can enhance continuous learning, flexibility, creativity, and problem-solving skills. Similarly, Xu et al. (2020) assert that robots can contribute to efficiency and productivity improvements. However, they caution that challenges such as high costs, skill shortages, and substantial changes in organizational structure and culture may accompany their implementation.

4.1.4.2. Training and development. Nine research articles investigated *training and development* at the individual ($n = 6$) and organizational ($n = 3$) levels.

In terms of *antecedents*, the prerequisites considered for robotics implementation for training and development include improving skills and decision making (Bonnaud and Bsiesy, 2020; Lindsay et al., 2014), maximizing learning and knowledge sharing within organizations (Ding, 2021), improve virtual collaboration in teams (Lindsay et al., 2014), optimize interaction and learning between humans and machines (Parvez et al., 2022), continuing research and development, expanding business scope, and updating management systems (Chuang, 2024; Nichols, 2020).

In terms of *phenomenon*, the prominent outcomes and topics for the study of training and development using robotics include learning skills (Ding, 2021), innovation capabilities (Bonnaud and Bsiesy, 2020), problem solving and decision-making capabilities (Zhong et al., 2022; McKinsey, 2022), and assisting employees and robots to coexist in a technologically dynamic workplace (Chuang, 2020; McKinsey, 2022).

In terms of *consequences*, the studies that provided a practical link between robotics and training and development include Ballestar et al.'s (2020) study, which argues that it is important that robots contribute to HRM decision making and the development of technical expertise, especially for small and medium enterprises, to benefit from innovation and influence future export trade, as well as Ding's (2021) study, which highlights that employees and machines interact with each other and thus lead to competitive work attitudes and behaviors, thereby implying to policymakers that adequate resources and professional development opportunities should be provided to support employees' professional competencies.

4.1.4.3. Employee and labor relations. Eight research articles examined *employee and labor relations*. These articles were analyzed at the individual ($n = 6$) and organizational ($n = 2$) levels.

In terms of *antecedents*, the reasons for engaging in robotics for managing employee and labor relations include solving communication problems within organizations (Gombolay et al., 2015), robot awareness and mutual trust (Khaliq et al., 2022; McKinsey, 2022), helping organizations deal with uncertainty and complexity (Anshari et al., 2021), reducing costs, improving accuracy and speed (Khaliq et al., 2022; McKinsey, 2022), strengthening positioning and job security, managing concerns, and anticipating change (Chao and Kozlowski, 1986).

In terms of *phenomenon*, the prominent outcomes and topics for the study of managing employee and labor relations using robotics include effective/ineffective communication at work, team effectiveness and work with robots (Gombolay et al., 2015), interpersonal relationship building (Parvez et al., 2022), predicting willingness to leave (Khaliq et al., 2022; Ogbeibu et al., 2021), and technological unemployment (Chao and Kozlowski, 1986; Techatassanasoontorn et al., 2023).

In terms of *consequences*, the studies that provided a practical link between robotics and managing employee and labor relations include Parvez et al.'s (2022) study, which show that robots can streamline communication and human team processes within organizations, as well as Khaliq et al. (2022) study, which supports the aforementioned study by highlighting that robots are helping humans, not replacing them, by helping to solve redundant and low-skilled jobs and avoiding technological stress.

4.1.4.4. Appraisal and motivation. Six research articles examined *appraisal and motivation* at the individual ($n = 3$) and organizational ($n = 3$) levels.

In terms of *antecedents*, the link between robotics and appraisal and motivation practices was mainly triggered by factors such as optimization of work performance (Erro-Garcés and Aramendia-Muneta, 2023; Nankervis et al., 2021), improvement of employee productivity (Grencikova et al., 2020;; Nichols, 2020; Nankervis et al., 2021),

Table 3
Robot-HRM: HR practices across the logic of "antecedents-phenomenon-consequences".

HR practices	Antecedents	Phenomenon	Consequences
	Purposes or reasons	**Key features, practices, or outcomes**	**Impact or practical implications**
Human resource planning	Improving operational efficiency and quality. Improving task design and execution capabilities. Improving workers' skills. Reducing employee burden and saving costs. Enhance interaction and collaboration among remote team members.	Employee cooperation capabilities. Employee productivity and efficiency. Employee turnover or unemployment. Work agility. Complementarity between robotics and HR.	Robots can be used to continuously evaluate task assignments to ensure a match with employee needs. Robots need to be integrated into employees' work so they are more easily accepted by employees. Managers need to understand future job profiles and employee competencies, as well as their collaborative relationship with robotics. The use of robots may present challenges such as high costs, skill shortages, and significant changes in organizational structure and culture.
	Individual level: Bhattacharyya and Nair (2019), Chuang (2020), Flechsig et al. (2022), Jerman et al. (2020), Parvez et al. (2022), and Xu et al. (2020). Organizational level: Cai et al. (2020), Obashi and Kimura (2021), and Šimek and Šperka (2019).		
Training and development	Improve skills and decision-making capabilities. Maximizing learning and knowledge sharing within the organization. Improving virtual collaboration in teams. Optimizing interaction and learning between people and machines. Continuous research and development to expand the scope of operations and update management systems.	Learning skills. Innovation skills. Problem solving and decision-making skills. Assisting employees and robots to coexist in a technologically dynamic workplace.	Robotics contributes to HRM decision making and technical expertise. Robots have the potential to contribute to HRM processes to enhance HR effectiveness. HRM departments can make employees more sensitive to robotic collaboration issues and help develop a sense of collaboration among employees. Virtual settings for collaboration can lead to the creation or discovery of tacit knowledge. Employees and machines interacting with each other will lead to competitive work attitudes and behaviors.
	Individual level: Chuang (2020, 2024), Ding (2021), Lindsay et al. (2014), Parvez et al. (2022), and Zhong et al. (2022). Organizational level: Ballestar et al. (2020), Bonnaud and Bsiesy (2020), and Cai et al. (2020).		
Employee and labor relations	Resolving communication issues within the organization. Robot awareness and mutual trust. Helping organizations deal with uncertainty and complexity. Cost reduction, accuracy, and speed. Positioning, job security, managing concerns and anticipating change. Robot awareness and mutual trust.	Effective/ineffective communication at work. Maximizing team effectiveness. The desire to work with robots. Interpersonal relationship building. Predicting the willingness to leave a job. Technological unemployment.	Combining workforce and robotics allows for improved interactions and the pursuit of new possibilities and opportunities. Using robots to select employees and predict worker productivity increases productivity and social gains. Robots can streamline communication and human team processes within an organization. Robots help solve redundant and low-skilled jobs and avoid technology stress, as well as reduce employee stress and work-life conflict.
	Individual level: Anshari et al. (2021), Chao and Kozlowski (1986), Gombolay et al. (2015), Khaliq et al. (2022), Parvez et al. (2022), and Techatassanasoontorn et al. (2023). Organizational level: Melián-González and Bulchand-Gidumal (2020), and Ogbeibu et al. (2021).		
Appraisal and motivation	Optimization of work performance. Improving employee productivity. Streamlining of processes. Improving skills and interprofessional collaboration. Improving discipline issues.	Employee performance. Employee productivity. Employee motivation. Job satisfaction. Workforce reduction.	Robotics can help evaluate social HR practices. Robots can help identify goals that HRM can use to motivate and reward employees. Robots can increase team members' awareness and improve team performance. Robots respond to employee behaviors and needs and provide personalized and adaptive services that increase their productivity. HRM can foster a commitment to robotic practices and values. HRM departments choose to use robots to improve employee performance, reducing the need for managers to oversee worker activities to ensure product quality. HRM departments can reduce labor costs.
	Individual level: Lindsay et al. (2014), Nankervis et al. (2021), and Parvez et al. (2022). Organizational level: Dixon et al. (2021), Grencikova et al. (2020), and Erro-Garcés and Aramendia-Muneta (2023).		
Recruitment and selection	Automatic collection of candidate files, extraction, and pre-processing tasks of key candidate information. Supporting workforce planning and recruitment functions. Making employee selection more effective. Facilitating organizational change.	Reduction in internal mobility and outsourcing. Employment/unemployment. Achieving cultural change.	Robots can help HRM departments automatically pre-select candidates that are a good fit for existing teams and future team members. Improves the effectiveness of the talent acquisition function and leads to organizational sustainability development. Streamline HR processes and quickly increase the overall value of the organization. Tensions and conflicts caused by the replacement of service workers and the gradual institutionalization of robotization.
	Individual level: Cristina and Corneliu (2021), Figueiredo and Pinto (2020), Gupta et al. (2018), and Pasparakis et al. (2023). Organizational level: Dixon et al. (2021).		

(*continued on next page*)

Table 3 (*continued*)

HR practices	Antecedents	Phenomenon	Consequences
	Purposes or reasons	Key features, practices, or outcomes	Impact or practical implications
Health, safety and wellbeing	Reducing work complexity and security risks. Replacing technological redundancies.	Assist in checking the safety of personal protective equipment, monitoring construction progress, delivering materials, and cleaning. Job satisfaction. Psychological stress from pay cuts.	Use robots to analyze and predict jobs that are at risk. Robots can increase managers' awareness of safety issues in work environments with various levels of hazards. Assume support roles and take on dangerous and demanding jobs while humans perform dexterity and/or problem-solving activities. Addresses talent shortages, job hazards, and skilled unemployment
	Individual level: Chao and Kozlowski (1986), Chuang (2020), De Obesso et al. (2023), and Kim et al. (2022)		

streamlining processes (Lindsay et al., 2014; McKinsey, 2022; Parvez et al., 2022), improving skills, and interprofessional collaboration (Nankervis et al., 2021).

In terms of *phenomenon*, the prominent outcomes and topics for the study of appraisal and motivation using robotics include employee performance (Nankervis et al., 2021), employee productivity (Dixon et al., 2021; Nankervis et al., 2021), employee motivation (Lindsay et al., 2014), job satisfaction (Lindsay et al., 2014), and labor reduction (Grencikova et al., 2020; Melián-González and Bulchand-Gidumal, 2020).

In terms of *consequences*, the scholars that provided a practical link between robotics and appraisal and motivation include Dixon et al. (2021), who highlight that incorporating robots in the workplace can diminish the requirement for managers to closely monitor workers to ensure product quality, and that investments in robots are anticipated to enhance performance measurement and facilitate the implementation of incentive pay systems based on individual employee performance.

4.1.4.5. Recruitment and selection. Five research articles examined *recruitment and selection*. These articles were analyzed at the individual ($n = 4$) and organizational ($n = 1$) levels.

In terms of *antecedents*, the reasons for engaging in robotics for recruitment and selection include the benefit of automated collection of candidate documents, extraction, and pre-processing tasks of key information about candidates (Cristina and Corneliu, 2021), supporting workforce planning and recruitment functions (Gupta et al., 2018), making employee selection more effective (Dixon et al., 2021), as well as facilitating organizational change (Figueiredo and Pinto, 2020).

In terms of *phenomenon*, the prominent outcomes and topics for the study of recruitment and selection using robotics include the incorporation of technology into HRM service processes to achieve cultural change (Gupta et al., 2018), and the outsourcing and employment/unemployment paradox that raises contradictions from the progressive institutionalization of robotization (Figueiredo and Pinto, 2020; Pasparakis et al., 2023).

In terms of *consequences*, the studies that provided a practical link between robotics and recruitment and selection include Cristina and Corneliu (2021) study, which asserts that robots can help automatically pre-select candidates for existing teams and future team members and thus streamlining HR processes and increase the overall value of the enterprise, as well as Figueiredo and Pinto's (2020) study, which highlights that tensions emerging from progressive institutionalization through robotization in service organizations can arise when service workers are forced to accept increased tasks and responsibilities or risk getting replaced by robots.

4.1.4.6. Health, safety, and wellbeing. Four research articles examined *health, safety, and wellbeing*. These articles were analyzed at the individual ($n = 4$) level only, thereby represented the smallest studied phenomenon.

In terms of *antecedents*, the reasons for using robotics for health, safety, and wellbeing include the need to reduce work complexity and security risks (Kim et al., McKinsey, 2022) and mitigate alternative technology redundancy (Chuang, 2020).

In terms of *phenomenon*, the prominent outcomes and topics for the study of health, safety, and wellbeing using robotics include robotics assistance in checking the safety of personal protective equipment, monitoring construction progress, delivering materials, and cleaning (Kim et al., 2022), as well as the psychological stress associated with pay cuts (Chao and Kozlowski, 1986; De Obesso et al., 2023).

In terms of *consequences*, the studies that provided a practical link between robotics and health, safety, and wellbeing include Kim et al.'s (2022) study, which suggests that robots can assume supportive roles, tackling dangerous and physically demanding tasks, while humans focus on activities requiring dexterity and problem-solving abilities. Similarly, Chuang (2020) argues that advanced technologies have the potential to address talent shortages, mitigate job hazards, and combat technological unemployment in HRM. Therefore, managers would greatly benefit from a comprehensive understanding of how technological advancements impact skills that are resistant to automation, job positions that may be at risk, and the development of alternative job skills.

4.2. How do we know about robotics implementation for HRM in the workplace (RQ2)

The present section builds on the preceding section and dives into the ways in which understanding of robot-HRM was developed. In line with the TCCM framework, this section sheds light into the remaining parts of the framework other than "characteristics"—namely, (i) theories, (ii) contexts, and (iii) methods.

4.2.1. Theories for robot-HRM research

There is nothing as practical as a good theory (Lim, 2022) and thus it is important for empirical studies to include at least one theory when developing research ideas, justifying findings, and providing recommendations (Stewart and Klein, 2016). Yet, only 11 research articles on robot-HRM were guided by theory while the others did not include any theoretical lens for their research (Table 4). The most popular theories were the technology acceptance model and sociotechnical systems theory, each mentioned in two articles, followed by social representations theory, cognitive appraisal theory, conservation of resources theory, institutional theory, organizational sense-making theory, person-environment fit theory, and stakeholder theory with one article each.

4.2.1.1. Technology acceptance model (TAM). The TAM was developed by Davis (1989) and is widely used to predict the adoption of advanced technologies. According to this theory, technology adoption is influenced by two factors: perceived ease of use and perceived usefulness. Building on the TAM, a recent study conducted by Parvez et al. (2022) examined the impact of perceived ease of use, perceived usefulness, and robotic awareness on human-robot collaboration in work environments. Similarly, Kim et al. (2022) applied the TAM to investigate the relationship between job complexity, perceived safety risks, and workers' expectations of competence and perceived usefulness of robots in the

Table 4
Prominent theoretical lenses in robot-HRM research.

Theory	Original source	Article (s)	Robot-HRM research source
Technology acceptance model	Davis (1989)	2	Kim et al. (2022), Parvez et al. (2022)
Sociotechnical systems theory	Trist and Bamforth (1951)	2	Berkers et al. (2023), Chuang (2024)
Stakeholder theory	Freeman (1984)	1	Zhong et al. (2022)
Social representations theory	Moscovici (1984)	1	Na et al. (2023)
Cognitive appraisal theory	Lazarus and Folkman (1984)	1	Ding (2021)
Conservation of resources theory	Hobfoll (1989)	1	Khaliq et al. (2022)
Institutional theory	Scott (1987)	1	Figueiredo and Pinto (2020)
Organizational sense-making theory	Weick (1995)	1	Stein and Scholz (2020)
Person-environment fit theory	Edwards et al. (1998)	1	Ding (2021)

workplace. These studies demonstrate the relevance of the TAM in understanding the factors that influence human-robot collaboration and the acceptance of robots in various work settings. Extending the TAM, researchers are able to explore additional variables that play a role in shaping individuals' perceptions and expectations regarding robotic technologies.

4.2.1.2. Stakeholder theory. The stakeholder theory introduced by Freeman (1984) posits stakeholders as individuals or groups who can impact or be impacted by an organization's goals. According to this theory, organizations should ensure the well-being and security of their stakeholders, including management, employees, suppliers, and the surrounding community (Andries and Stephan, 2019). Building on this theory, Zhong et al. (2022) conducted a study that explored the relationship between the implementation of robotics and career satisfaction among various stakeholders, such as managers, financial officers, and staff. The study discovered a positive correlation between the use of robotics and career satisfaction among these stakeholders. Prioritizing the well-being and satisfaction of stakeholders, organizations can create a positive and supportive work environment that embraces technological advancements. Incorporating robotics in a manner that aligns with stakeholder interests should lead to improved organizational outcomes and foster a culture of continuous improvement and employee satisfaction.

4.2.1.3. Sociotechnical systems theory. The sociotechnical systems theory underscores the significance of choice, focusing on the interaction between the social systems within organizations (employees and their interactions) and technological systems (technical tools and processes). It advocates for the joint optimization of these two systems to minimize inconsistencies and disparities (Trist and Bamforth, 1951). Building on this theory, Berkers et al. (2023) posited that work design should concurrently consider the optimization of both social and technological systems. Their research revealed that the introduction of robots in logistics warehouses significantly impacted the work design of order picking and packaging employees. Recently, Chuang (2024) proposed that strategic decisions should take a comprehensive approach to considering both social (human) and technological subsystems and design them to adapt to environmental demands, thereby enhancing organizational effectiveness. The study found that the human skills (social and decision-making skills) possessed by the interviewed employees varied between educational levels and genders.

4.2.1.4. Social representations theory. The social representations theory proposed by Moscovici (1984) elucidates a system comprised of views, knowledge, values, beliefs, emotions, attitudes, and practices regarding social objects within a social environment. These elements are specific to cultural, social categories, or groups (Rateau et al., 2012). Building upon the theory of social representations, Na et al. (2023) explored how two distinct groups—nursing service managers and nursing workers—understand the social representations of care robots held by different stakeholders. The research revealed that nursing service managers held negative social representations of care robots, whereas nursing workers had positive representations.

4.2.1.5. Cognitive appraisal theory. The cognitive appraisal theory introduced by Lazarus and Folkman (1984) provides insights into the psychological processes influenced by stressors. Cognitive appraisal refers to the evaluation process in which individuals assess the relevance of a specific interaction with the environment to their well-being and determine the ways in which it affects them (Folkman et al., 1986). Ding (2021) contributed by extending the theoretical generalizability of this theory by applying it to the context of innovation in technology organizations. Specifically, the study examined how employees perceive challenges and obstacles related to robot awareness and explored the potential of robots as a source of job stress. Extending the cognitive appraisal theory, the research sheds light on the understanding of employees' assessment of the impact of robots in the workplace and their potential implications for job-related stress.

4.2.1.6. Conservation of resources theory. The conservation of resources theory proposed by Hobfoll (1989) predicts that resource loss is the main factor in the stress process. According to this theory, individuals possess a limited amount of resources and constantly strive to preserve, acquire, and maintain them (Yousaf, 2021). Strong resource reserves enable individuals to better cope with stress and overcome daily challenges (Hobfoll, 1989). The significance of resources varies for each person, depending on their unique experiences and circumstances (Du et al., 2021). The study conducted by Khaliq et al. (2022) employed this theoretical framework to investigate the relationship between robot awareness and employees' higher turnover intention. Drawing upon the conservation of resources theory, the researchers established a solid theoretical foundation to explore how individuals' perception of robots in the workplace affects their intention to leave their jobs.

4.2.1.7. Institutional theory. The institutional theory developed by Scott (1987) posits that institutions comprise cultural-cognitive, normative, and regulatory elements that collectively establish stability and significance in society. Institutionalization is achieved through three forms of institutional isomorphism: coercive, normative, and mimetic (DiMaggio and Powell, 1983). Building on this theory, Figueiredo and Pinto (2020) demonstrated that incorporating technology, innovation, and process automation enhances the understanding of robotization within the framework of institutional theory.

4.2.1.8. Organizational sense-making theory. The organizational sense-making theory was proposed by Weick (1995) and focuses on how individuals and groups attribute meaning to their experiences, reducing ambiguity in communication. This theory is particularly relevant to understanding the employee perspective within organizations as it influences how structural changes are perceived as rational choices (Schoemaker, 1993). In a recent study by Stein and Scholz (2020), the authors applied this theory to explore the interaction between human and robotic automation technologies in smart factories. Their findings revealed that while the benefits of automation are sustainable and easily replicable, incorporating these technologies alongside human resources presents significant challenges. Noteworthily, human resources are diverse and unique, making direct replacements of human labor highly difficult.

4.2.1.9. Person-environment fit theory. Person-environment fit theory was introduced by Edwards et al. (1998) and focuses on assessing the compatibility between an individual and their environment. This theory has been widely employed to explore the connections between individuals' cognition, attitudes, and their impact on organizational behavior and human resource management (Abdalla et al., 2018; Chang et al., 2020). Ding (2021) utilized this theory in conjunction with cognitive appraisal theory to examine the relationship between employees' perception of barriers to robot awareness and their level of work engagement. The findings of the study suggest that the lack of a significant relationship between these factors could be attributed to the current stage of robotics' development and adoption, as well as the long-term prospects, which may not have received substantial attention from employees at the present moment. However, it is important to note that as robotics become increasingly prevalent in society over time, employees' perceptions and engagement with this technology may undergo significant changes. This highlights the need for further exploration as robotics continue to evolve and integrate into various aspects of the workforce and society as a whole.

4.2.2. Contexts for robot-HRM research

Contexts refer to the circumstances involved in the investigation (Lim et al., 2021). In the present review, the contexts of 59 articles can be classified into four aspects: populations, platforms, industries, and countries (Fig. 4 and Table 5).[1]

In terms of *populations*, 34.62 % of studies ($n = 18$) sampled employees as a unit of analysis, whereas 28.85 % of studies ($n = 15$) concentrated on managers. Other units of analysis included experts ($n = 8$) and organizations from a single country ($n = 7$) or multiple countries ($n = 3$).

In terms of data collection *platforms*, 44.23 % of studies used online platforms ($n = 23$), 42.31 % of studies used offline platforms ($n = 22$), and 11.54 % of studies used a combination of online and offline platforms ($n = 6$).

In terms of *industries*, most studies concentrated on the general labor market (28.85 %; $n = 15$) and tourism and hospitality (19.23 %; $n = 10$), followed by manufacturing (15.38 %; $n = 8$). Other industries such as automotive, green energy, and public health are still in an exploratory stage, and thus, represent potential areas for new robot-HRM exploration.

In terms of *countries*, the studies were spread across 33 countries. Most studies were conducted in the United States (20.34 %; $n = 12$). Other notable countries include the United Kingdom (13.56 %, $n = 8$), Australia (8.47 %; $n = 5$), China (8.47 %; $n = 5$), and Spain (6.78 %; $n = 4$). This seems to reflect a large extent of the achievements and investments in robot technology in these countries. Nonetheless, greater representation of robot-HRM practices in other countries that remain unexplored or underexplored is needed for greater diversity and inclusivity in insights.

4.2.3. Methods for robot-HRM research

Methods refers to the analytical techniques involved in the investigation (Lim et al., 2021). In the present review, the methods used to analyze the data of the 59 studies can be classified according to five analytical techniques: conceptual, qualitative, quantitative, experimental, and mixed methods (Table 6).

Table 6 shows that qualitative ($n = 20$) and quantitative ($n = 18$) are commonly used methods for robot-HRM research. Qualitative studies often rely on content analysis ($n = 17$) and case studies ($n = 3$), whereas quantitative studies often involve structural equation modeling ($n = 9$), test of difference ($n = 6$), and regression analysis ($n = 3$)—these studies often provide insights into the associations between different concepts in robot-HRM. Conceptual studies ($n = 3$), which provide insights into concepts and issues in robot-HRM, and experimental studies ($n = 4$), which provide insights into the causes and effects among concepts in robot-HRM, are a minority and thus could be pursued with greater intensity in the future given the importance of the former in providing a conceptual foundation for qualitative and quantitative studies and the latter in establishing causality (Lim et al., 2022). Six studies used mixed methods (Cristina and Corneliu, 2021; Nankervis et al., 2021; Sadanghar, 2022; Ulatowska et al., 2023; Yu et al., 2023; Zhong et al., 2022), and similar to conceptual and experimental studies, they remain a minority in robot-HRM research, and thus, they are encouraged in future research, mainly due to the comprehensiveness and rigor that can be acquired through mix methods studies (Lim et al., 2022).

5. Future research agenda (RQ3)

Building on the insights in the preceding sections (RQ1 and RQ2), this section concentrates on answering the question of *where should research go with robotics for HRM in the workplace* (RQ3). The answers are curated in the form of a future research agenda that is divided into four sections: (i) new theories perspective, (ii) new research settings, (iii) new constructs for future studies, and (iv) new methods for future studies.

5.1. New theories perspective for robot-HRM research

Existing robot-HRM research reported in this review drew theoretical underpinnings from several theories, including the cognitive appraisal theory, the conservation of resources theory, and the TAM, among others. However, the toolbox of relevant theories remains lacking (i.e., only nine theories), thereby limiting understanding of the overall impact of robotics on HRM at the individual and organizational levels. This, in turn, represents a gap that prospective scholars can fill by pursuing alternative theories for robot-HRM research.

Firstly, future research could further explore the *unified theory of acceptance and use of technology* (*UTAUT*) (Venkatesh et al., 2003). UTAUT considers eight competing theories and models of technology acceptance (i.e., diffusion of innovations theory, model of personal computer use, motivational model, social cognitive theory, TAM, theory of planned behavior, theory of reasoned action, and a combined technology acceptance model/theory of planned behavior) (Venkatesh et al., 2003). In this sense, this theory provides a more comprehensive and integrated approach in explaining technology acceptance and use (San Martín and Herrero, 2012). UTAUT also outlines four crucial factors that influence the adoption of technology: performance expectations, effort expectations, social influence, and facilitating conditions. Additionally, the theory identifies four moderators that can impact the relationship between these factors and technology adoption: age, gender, experience, and voluntariness of use. Thus, UTAUT can be used not only to explain the organizational acceptance of technological innovation (e.g., robotics), but also to predict individuals' behavioral intentions in the different stages of technology adoption and use. Using UTAUT as theoretical lens, future research could extend robot-HRM research to a broader perspective that captures the adoption behaviors of individual employees and organizations to use robots for HRM in the workplace in the future. In addition, few HRM studies include sociodemographic factors in robotics exploration in HRM, and thus, the four sociodemographic moderators of UTAUT can support future scholars who intend to track the changes between early and late robot users in the workplace through a longitudinal study.

Secondly, robots have been signaled as a solution across different countries, industries, and occupations to address talent shortages and job hazards (Chuang, 2020), save costs (Flechsig et al., 2022; Song and Kim, 2022), and enhance collaboration (Obashi and Kimura, 2021; Parvez et al., 2022). Therefore, it is important to understand the theoretical basis for the full range of values sought from robots. In this case, future research could assess the strategic plans and applications of robot-

[1] For some studies, data was collected from multiple units of analysis and countries.

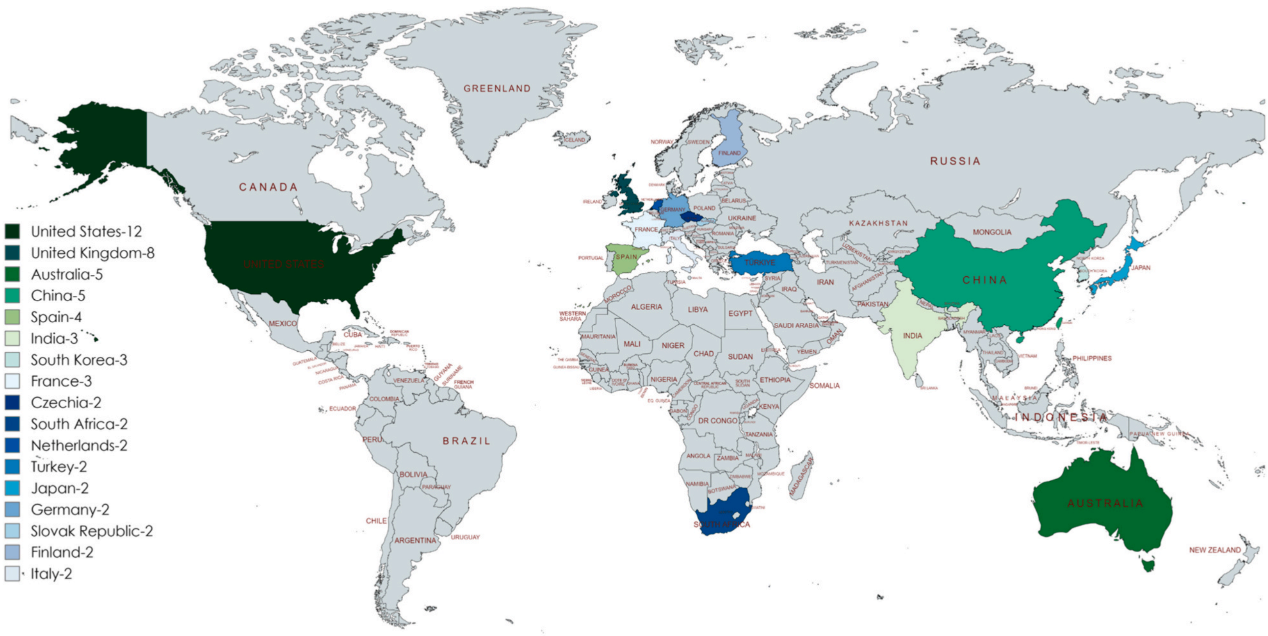

Fig. 4. Countries where robot-HRM has been studied.
Notes: Each color represents a country. Color tone represents the number of studies. Darker color tone indicates more studies and lighter color tone implies less studies.

Table 5
Contextual coverage of robot-HRM research.

Context	*n* of articles	% of articles
Units of analysis (populations)		
Individual (Employees)	18	34.62 %
Individual (Managers)	15	28.85 %
Individual (Experts)	8	15.38 %
Organizational (Single country)	7	13.46 %
Organizational (Multiple countries)	3	5.77 %
Platforms		
Online	23	44.23 %
Offline	22	42.31 %
Online and offline	6	11.54 %
Industries		
General labor market	15	28.85 %
Tourism and hospitality	10	19.23 %
Manufacturing	8	15.38 %
Higher education	5	9.62 %
Network trade	4	7.69 %
Construction	4	7.69 %
Small and medium enterprise	3	5.77 %
Shared service centers	1	1.92 %
Purchasing and supply management	1	1.92 %
Global accounting services	1	1.92 %
Automotive	1	1.92 %
Green energy	1	1.92 %
Public health	1	1.92 %

HRM through *signaling theory*. Signaling theory, as proposed by Spence (1978), refers to the process through which an entity aims to convey crucial information to influence a favorable decision by another entity. The fundamental aspect of this theory lies in the examination of different signal types and their respective contexts of application (Spence, 2002). By applying signaling theory in the field of HRM, it becomes possible to expand the understanding of how signals can be utilized by robots as the signalers, while individuals and organizations serve as the receivers. This perspective allows for a deeper exploration of how robots can effectively address HRM challenges and generate value and outcomes for both individuals, such as increased competitiveness, interactivity, and novelty, and organizations, such as facilitating organizational change, enhancing return-on-investment, and reducing costs. By incorporating signaling theory into HRM studies, a more comprehensive understanding of the role of robots as signals can be achieved, shedding light on their potential contributions to HRM practices.

Finally, other prominent theories that could prove useful include *ability-motivation-opportunity theory* (Bailey, 1993), *construal level theory* (Trope and Liberman, 2010), *decision theory* (Frantz, 2003), *flow theory* (Csikszentmihalyi, 1991), *value-based adoption model* (Kim et al., 2007), *situational interaction theory* (Woodman et al., 1993), and *theory of behavioral control* (Lim and Weissmann, 2023). These theories can provide support in explaining the considerations in decision making, perception shaping, interaction engagement, and overall satisfaction in the workplace. Likewise, future research could extend the theories to managerial decisions at the individual level in relation to job responsibilities, time management, and loyalty decisions, as well as the organizational level in relation to employment behavior and employee training. Therefore, prospective scholars are encouraged to consider using the suggested theories to further explore the field of robot-HRM.

5.2. New research settings for robot-HRM research

Many studies on robot-HRM are concentrated in the United States, the United Kingdom, and Australia, while research in developing countries has also started to explore the potential of robotics usage in the workplace, though the adoption of innovative technologies seems to be heavily dependent on the environment (Van Geffen et al., 2013). Recent research calls for technology-based HRM and the need to explore the impact of the international environment on the implementation process (Bondarouk and Brewster, 2016). For example, robots were featured recently at the XXIV Olympic Winter Games that was held in Beijing, China, in February 2022. Robots were acting as "volunteers", "waiters", and "chefs" among many other roles. In fact, 72% of China's leading FinTech companies are using robots in their business environment (Statista, 2022b). Hence, the market demand for robotics is a major driver across many industries such as education, healthcare, and public services. As the world embraces the digital era and the new normal following the COVID-19 pandemic (Lim, 2021), the demand for human-robot collaboration is poised to proliferate, ushering new growth

Table 6
Analytical choices of robot-HRM research.

Methods	Frequency	Articles
Conceptual	3	Arslan et al. (2022), Fleming (2019), and Stein and Scholz (2020).
Qualitative		
Content analysis (including Delphi; software = NVIVO)	17	Anshari et al. (2021), Bhattacharyya and Nair (2019), Cai et al. (2020), Figueiredo and Pinto (2020), Gupta et al. (2018), Jerman et al. (2020), Kim et al. (2022), Knod et al. (1984), Lindsay et al. (2014), Macpherson et al. (2023), Melián-González and Bulchand-Gidumal (2020), Rosenthal (1984), Shenkar (1990), Šimek and Šperka (2019), Stanley and Aggarwal (2019), Techatassanasoontorn et al. (2023), and Xu et al. (2020).
Case study	3	Flechsig et al. (2022), Lim and Lee (2019), and Lam et al. (2024).
Quantitative		
Structural equation modeling (e.g., method = covariance-based, partial least squares; software = AMOS, SmartPLS, WarpPLS)	9	Ballestar et al. (2020), Ding (2021), Ghobakhloo et al. (2023), Khaliq et al. (2022), Obashi and Kimura (2021), Odugbesan et al. (2023), Ogbeibu et al. (2021), Ogbeibu et al. (2024), and Parvez et al. (2022).
Test of difference (e.g., ANOVA, chi-square tests)	6	Ayres and Miller (1982), Bonnaud and Bsiesy (2020), Chao and Kozlowski (1986), Chuang (2020), Chuang (2024), and Grencíková and Vojtovic (2017).
Regression analysis (e.g., methods = hierarchical, logistic, logit, stepwise; software = SPSS)	3	Del Giudice et al. (2021), Dixon et al. (2021), and Grencikova et al. (2020).
Experiment (e.g., methods = multiple experiment, simulated experiment)	4	Bogataj et al. (2019), Gombolay et al. (2015), Lu et al. (2023), and Pasparakis et al. (2023).
Mixed methods		
Qualitative and quantitative	6	Cristina and Corneliu (2021), Nankervis et al. (2021), Sadangharn (2022), Ulatowska et al. (2023), Yu et al. (2023), and Zhong et al. (2022).

opportunities in the coming years (Lim et al., 2024). Therefore, prospective scholars interested in robot-HRM could engage in comparative studies across countries and industries to shed new light and improve the generalizability of findings for finer-grained and more-informed policy insights.

5.3. New constructs for future studies on robot-HRM

The discourse surrounding the integration of robotics within HRM often paints a dichotomous picture: on one side, the tangible benefits such as enhanced employee productivity (Xu et al., 2020; Nankervis et al., 2021), interpersonal dynamics, (Parvez et al., 2022), and skills (Ding, 2021) stand testament to robotics' value at an individual level. Conversely, the narrative shifts when addressing the organizational spectrum, where the discourse predominantly orbits around potential drawbacks, notably technological unemployment, with less emphasis on strategic countermeasures. This dichotomy underscores a critical gap in the robot-HRM literature, which often glosses over robotics' positive and negative ramifications, particularly in mitigating adverse impacts on employment. McKinsey's (2017) forecast of robots displacing over 800 million jobs globally by 2030 casts a shadow of apprehension, fueling debates on the robotic usurpation of employment (Makarius et al., 2020). Yet, this narrative necessitates a broader lens, recognizing that technological evolution primarily transforms job roles rather than eradicating them outright. The displacement in manual labor tasks by industrial robots and routine service roles by AI-driven solutions, such as chatbots, heralds a paradigm shift rather than a job market contraction. This transition mirrors historical precedents set by the industrial and digital revolutions, which, despite initial disruptions, culminated in the genesis of novel employment sectors, driving economic expansion and labor market evolution. Therefore, in navigating this transformative era, the pivotal role of education and skills development emerges as a linchpin, equipping the workforce for impending market demands (Lim, 2023a; Ogbeibu et al., 2024).

Furthermore, a recalibrated perspective that views robotics as an augmentative force to human capabilities, rather than a replacement, can unlock new dimensions of innovation and productivity across sectors. However, the integration of robotics, particularly those reliant on extensive datasets and sophisticated algorithms, introduces a spectrum of risks encompassing data security breaches, privacy intrusions, and ethical dilemmas. The potential for algorithmic bias, manifesting in discriminatory outcomes, underscores the imperative for a balanced examination within robot-HRM research. This approach necessitates a holistic appraisal that not only celebrates robotics' efficiencies and strategic advantages but also critically addresses the ethical, privacy, and socio-economic implications, forging a pathway that harmonizes technological advancement with ethical stewardship and social equity (Čaić et al., 2018).

Moreover, for scholars interested in the field of robot-HRM, exploring the concept of anthropomorphism in robot services is essential. This includes examining aspects such as the physical appearance of robots (e.g., cute versus cool) and human-robot interaction (Lim et al., 2022; Lim et al., 2024). Anthropomorphism refers to the psychological phenomenon where humans attribute human-like characteristics to non-human entities, including animals, plants, natural or social phenomena, supranatural entities, and technology; it involves engaging with these entities as if they were human, encompassing behaviors, feelings, and perceptions (Epley et al., 2007). The recent study by Vrontis et al. (2022) highlights that ensuring anthropomorphism in robots can foster human-technology engagements, leading to innovative approaches in managing employees and enhancing organizational performance. For instance, with thousands of job applicants, robots are increasingly employed in the hiring process of organizations to support tasks such as resume screening using their artificial intelligent systems and detecting fraud job seekers (e.g., screening resumes, or body language during the interview). Such an efficient access and evaluation of applicants' information can help organizations to hasten the screening process as well as getting the best candidate for employment. Moreover, robots can act as an assistant to human resources, answering a variety of frequently asked questions about organization policies (i.e., health benefits, leave utilization, and payroll inquiries), and thus, holding the potential to improve employee assurance and satisfaction. At the same time, the use of robots can help HR professionals to curate a fun training and development environment for employees so that they are more engaged and interactive, rather using the conventional way of watching videos or lecturing via presentations.

Ethical considerations represent another potential area for future robot-HRM research. Noteworthily, understanding ethically questionable management is critical to improving organizational behavior and culture (Fein et al., 2021). The inappropriate adoption of robots could lead to ethical issues such as risks to employee autonomy and privacy (Khaksar et al., 2024) as well the presence of data privacy and bias (Davenport et al., 2020). This is because robots can learn how to improve their work and can even make decisions, but of course, these are done through algorithms. Robots do not have the capacity for personal awareness and moral reasoning, and the reason for the lack of moral agency is human (Stahl and Coeckelbergh, 2016). This echoes the concept of "ethics by design," where programmers should ensure that human-centered social care and privacy are not compromised in the design of robots (Borenstein and Arkin, 2016; Tan et al., 2021). For example, introducing more design features in robot functionality, data privacy settings, close attention to input and operational systems, and regular risk assessments could mitigate potential ethical issues in the implementation of robotics for HRM in the workplace, though further research is required to ascertain the effectiveness of such strategies. There is also a need for an in-depth discussion of the broad ethical implications of robotics at the organizational level (Manthiou et al., 2021). Creating ethical cultures and policies (Ferrell and Ferrell, 2021) is an essential part of actively seeking for forward-looking solutions to manage the ethical challenges of robot-HRM practices. Therefore, future studies can observe the behavior in two different contexts: human-led and robot-assisted tasks versus robot-led and human-assisted tasks. Further exploration of the role that organizational-level stakeholders (e.g., companies, institutions) play in the ethical considerations of robots and the possible positive and negative effects of ethical climate is also encouraged. Ethical issues at different levels can be critically discussed in order to shape ethical robotics applications in ways that are corporately and socially responsible.

5.4. New methods for future studies on robot-HRM

The review shows a variety of analytical tools that have been applied to study robot-HRM. As technology upgrades, prospective scholars may wish to track feedback on the application of robot-HRM over a longer time, with longitudinal data investigating how robots influence the individual and organizational behavior and outcomes in the workplace, which could be done qualitatively and quantitatively, or both using mixed methods. Constructing realistic experimental scenarios and completing a number of simulated tasks in collaboration with robots could also prove useful to establish understanding on causes and effects of robot-HRM. Comparing the differential responses of different stakeholders (e.g., employees, managers, experts) across different situations (e.g., individual versus group tasks and decisions) should also lead to greater understanding of conditional effects in the field. Nevertheless, conceptual studies remain highly encouraged, as it is through conceptual studies that new ideas and ways of looking at robot-HRM issues are churned, which can then be validated through qualitative, quantitative, and experimental research.

6. Implications

Despite the various reviews that have been conducted on AI research in HRM (e.g., Kaushal et al., 2021; Qamar et al., 2021; Vrontis et al., 2022), the overarching view of robot-HRM insights remains scant. Building on past reviews in the field, this study provides new and meaningful insights to both HRM scholars and practitioners by presenting a state-of-the-art overview of current insights, research gaps, and future research directions. The theoretical and practical implications of the present study are summarized in the next sections.

6.1. Theoretical implications

In response to the three research questions posed earlier in this article, a comprehensive analysis of robot-HRM research was conducted based on the TCCM framework, which revealed the theories, contexts, characteristics, and methods in the field.

Firstly, this study described the publication trends, dissemination of journal articles, and citations of existing studies on robot-HRM before shedding light on the characteristics of robot-HRM research based on the antecedents-phenomenon-consequences logic. In doing so, this study contributes to a comprehensive understanding of the knowledge that exists in the field along with its performance in relation to publications (productivity) and citations (impact).

Secondly, this study presented the theories that have underpinned existing robot-HRM research. In the midst of doing so, this study noted that theory-based exploration of robot-HRM research is remains lacking, and thus, resulting in proposals for pursuing alternative theoretical perspectives, such as UTAUT (Venkatesh et al., 2003) and signaling theory (Spence, 1978). The alternative theories can provide alternative ways for shedding new light on the behavioral motivations of different stakeholders (e.g., employees, organizations) toward robot-HRM. In this regard, exploring and validating the experiences and behaviors of employees and organizations across different HR practices premised on solid theoretical foundations can help to contribute to the theoretical development of robot-HRM research (Pereira et al., 2023). Noteworthily, existing theories can also be combined or integrated with new theories to better understand the different levels of variation as well as the value and impact of robotics use for HRM in the workplace—existing theories provide a basis for generalizability when new findings reaffirm existing findings, whereas new theories provide a basis to formulate and validate new propositions.

Thirdly, this study analyzed the contexts of previous studies on robot-HRM, revealing that research in the field has been predominantly focused on developed countries (e.g., United States, United Kingdom, and Australia). This highlights the need to engage in new robot-HRM research across the different contexts of economic development and technological transformations. Though technologies supporting HR practices are universally recognized as important, many organizations may face a different set of challenges based on the unique peculiarities of their own context (e.g., availability of technology, level of technology development) (Kivimaa et al., 2019). Therefore, there is a need to identify cross-country robot-HRM practice differences and to investigate the role between the effectiveness of technology and the success of HRM along with potential moderators to explain the potential differences so that customized and targeted strategies can be formulated to ease the implementation of robotics for HRM in the workplace while getting the best value out. This will, in turn, have a more positive impact on the analysis of HR practice in both convergence and divergence aspects (Lindebaum et al., 2020).

Finally, this study sheds light on the methodological peculiarities of existing robot-HRM research in terms of analytical techniques. The results indicate that there is a significantly higher number of qualitative studies, relying primarily on content analysis and case studies, which leaves room for expanding the research agenda using alternative analytical techniques. The use of conceptual approaches, longitudinal data, and experimental designs is highly encouraged to contribute alternative and more powerful insights to the field of robot-HRM. Collecting longitudinal data across multiple time points along with an experimental approach could explain the conditions in behavioral outcomes of employees and organizations before and after robotics adoption and implementation. Such studies, when built upon sound conceptual insights on pertinent issues, can pave the way for new policies and strategies to improve human-robot collaborations in the future workplace.

Overall, this study contributes to the field of robot-HRM by highlighting the current state of the literature and its knowledge gaps, as well as suggesting future research directions, and thus, provides a solid foundation for future scholars to understand the possible role and impact of robot-HRM, as well as the ways in which new research in the field could be designed.

6.2. Practical implications

This study provides several useful insights for HR professionals managers when executing HRM functions using robotics in the workplace.

Firstly, robots have become integral to human resources planning, as well as in training and development practices. Technological advancements in robotics are reshaping the job landscape, phasing out traditional roles while paving the way for new, highly specialized positions across various sectors. Take Amazon's deployment of 'Kiva' robots in its warehouses as a case in point. These robots enhance storage and sorting processes, not only boosting operational efficiency but also igniting a vital conversation on the synergy between robotic and human labor. This shift brings to the forefront unique challenges for HRM, such as redefining job roles and addressing workforce concerns related to job displacement. In response to these evolving dynamics, HR professionals are urged to adopt proactive strategies to balance employment levels and mitigate the potential risks associated with automation. Amidst these technological advancements, fostering a culture of collaboration becomes paramount. This can be achieved through comprehensive education programs and promoting deep learning initiatives. It is also imperative for HR professionals, managers, and policymakers to craft multifaceted strategies that not only align with overarching business objectives but also enhance productivity and foster positive human-robot interactions. These strategies, coupled with innovative organizational models, should strive to minimize operational costs while bolstering employee engagement and commitment. A key aspect of this adaptation involves recognizing the irreplaceable value of human creativity and problem-solving skills, thereby ensuring technology complements rather than replaces manual tasks. Encouraging continuous learning and skill enhancement among employees will further cement their roles in this new era, ensuring sustained organizational success in an increasingly competitive marketplace.

Secondly, the advent of robotics in the workplace presents a complex challenge of potentially widening income disparities and straining interpersonal dynamics, particularly among diverse groups of employees. This situation necessitates a strategic approach by HR professionals to navigate between equitable compensation strategies and the integration of robotic assistance, wherein the goal is to attract and retain talent while ensuring fairness and equity across all employee segments. In this regard, HR professionals must explore and engage in innovative compensation models that reward individual performance and tenure while also considering the broader implications of robotics on the workforce (Pereira et al., 2023). This involves crafting compensation structures that reflect the value of both human and robotic contributions to organizational outcomes, ensuring that employees feel valued and fairly remunerated in an increasingly automated environment. More importantly, the deployment of robotics must also be thoughtfully managed to foster inclusivity and mitigate any adverse effects on interpersonal relations among employees. This entails developing robotics technologies that complement human skills and enhance collaboration rather than creating divisions. Along these lines, HR professionals play a pivotal role in facilitating dialogues and training programs that emphasize the synergistic potential of human-robot collaboration.

Thirdly, the integration of robotics within HR processes, particularly in recruitment and selection, heralds a new era in talent acquisition. For example, LinkedIn, exemplifying the automation and utilization of sophisticated algorithms, is revolutionizing the way candidates are identified, assessed, and matched with organizational needs, thereby streamlining the recruitment process and enhancing the precision of job-candidate alignments. This technological leap not only accelerates the talent acquisition cycle but also brings a higher degree of objectivity and data-driven insight into candidate evaluation. However, this automation does not eliminate the need for human oversight. The key to successful recruitment lies not just in algorithmic efficiency but also in the understanding of organizational culture, role dynamics, and the intangible qualities that potential employees bring to the table. Therefore, it is imperative for HR professionals to maintain an active role in overseeing and calibrating these robotic systems. Regular audits and updates in alignment with evolving organizational strategies, policies, and market dynamics are crucial to ensure that the AI-driven recruitment ecosystem remains adaptive, equitable, and in harmony with the organization's ethos and goals. This human-robot synergy in recruitment underscores the importance of a balanced approach, where technological capabilities are leveraged to optimize efficiency and reach, while human insights guide the process to ensure alignment with the organizational vision and human values, fostering a recruitment paradigm that is both innovative and inclusive.

Finally, studying the subtle aspects of the robot, such as the value that the robot creates in HRM functions, including personal safety and wellbeing (i.e., physical wellbeing, emotional wellbeing), are some of the important areas that are relevant to HR professionals and managers for decision making. The advent of health monitoring robots in the workplace exemplifies this trend, offering a glimpse into a future where robotics play a crucial role in safeguarding the physical and emotional well-being of employees (Lopes et al., 2023). These robots, deployed along production lines or within office environments, utilize advanced sensors to track vital health indicators such as body temperature and heart rate in a non-intrusive manner, thereby fostering a safer and more health-conscious workplace. As organizations increasingly integrate such robotic applications, the imperative for HR professionals extends beyond the mere implementation of technology, encompassing a responsibility to balance the benefits of robotic health monitoring with the protection of personal privacy and autonomy. Ensuring that these technological interventions are perceived not as intrusive surveillance but as benevolent guardians of health necessitates a careful and considered approach. This involves transparent communication about the purpose and function of health-monitoring robots, stringent data privacy protocols, and an unwavering commitment to using such technologies in a manner that respects and enhances the dignity and well-being of the workforce. In this context, HR professionals are called upon to be the custodians of a workplace culture that harmonizes technological innovation with human-centric values. Therefore, fostering an environment where robotics are leveraged to enhance rather than undermine personal safety and well-being should cultivate a sense of security and trust among employees. This not only improves the overall workplace experience but also reinforces the organization's commitment to its most valuable asset—its people.

7. Conclusion

Utilizing the TCCM framework (Paul and Rosado-Serrano, 2019), this study reviewed 59 studies on robot-HRM with the purpose of addressing three main research questions: (RQ1) What do we know about robotics implementation for HRM in the workplace (characteristics), (RQ2) How do we know about robotics implementation for HRM in the workplace (theories, contexts, methods), and (RQ3) Where should research go with robotics for HRM in the workplace. The results showed that robot-HRM has been widely published across 47 leading international journals, including *Journal of Applied Psychology*, *Journal of Operations Management*, and *Management Science*, though most publications are concentrated in recent years, indicating that robot-HRM research remains in infancy. Moreover, the antecedents-phenomenon-consequences logic was applied to analyze the multifaceted application of robot-HRM, with research in the areas of human resource planning and training and development leading the way. Qualitative research is more common in existing studies, though there is also much room for other analytical techniques such as conceptual, experimental, and mixed methods. The main theoretical basis for discussion is the technology acceptance model, with a lack of variety on theoretical lenses, indicating opportunities to introduce alternative theories, including in integrated ways, to advance the field of robot-HRM. Most studies have also analyzed robot-HRM at the individual level, with the general labor market being the most popular context, especially in the United States, the United Kingdom, and Australia, thereby indicating that future research at the organizational level and in developing countries is needed to add to the diversity and inclusivity of insights in the field. Finally, this study proposes future research directions based on the TCCM framework, summarizing the theoretical and practical implications, and thus, should serve as a useful resource for gaining retrospective and prospective insights on the use of robotics for HRM in the workplace.

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CRediT authorship contribution statement

Siqi Wang: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft. **Weng Marc Lim:** Conceptualization, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **Jun-Hwa Cheah:** Conceptualization, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing. **Xin-Jean Lim:** Conceptualization, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing.

Conflict of interest

None.

Data availability

Data is available in Scopus and Web of Science.

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None.

Appendix A

Table A1
List of articles included in the review ($n = 59$).

No.	Year	Source	Title
1	2024	Chuang	Indispensable skills for human employees in the age of robots and AI
2	2024	Ogbeibu et al.	Demystifying the roles of organizational smart technology, artificial intelligence, robotics and algorithms capability: A strategy for green human resource management and environmental sustainability
3	2024	Lam et al.	Raising logistics performance to new levels through digital transformation
4	2023	Ulatowska et al.	Digital transformation in HRM of the modern business service sector in Finland and Poland
5	2023	Techatassanasoontorn et al.	When Harry, the human, met Sally, the software robot: Metaphorical sensemaking and sensegiving around an emergent digital technology
6	2023	Ključnikov et al.	Global labour markets and workplaces in the age of intelligent machines
7	2023	Erro-Garcés and Aramendia-Muneta	The role of human resource management practices on the results of digitalisation. From Industry 4.0 to Industry 5.0
8	2023	Ghobakhloo et al.	Intelligent automation implementation and corporate sustainability performance: The enabling role of corporate social responsibility strategy
9	2023	Lu et al.	Digital twin-enabled human-robot collaborative teaming toward sustainable and healthy built environments
10	2023	De Obesso et al.	Artificial intelligence to manage workplace bullying
11	2023	Kilroy et al.	Embedding reciprocity in human resource management: A social exchange theory of the role of frontline managers
12	2023	Odugbesan et al.	Green talent management and employees' innovative work behavior: The roles of artificial intelligence and transformational leadership
13	2023	Na et al.	How do care service managers and workers perceive care robot adoption in elderly care facilities?
14	2023	Macpherson et al.	Talent approaches for the South African automotive industry
15	2023	Yu et al.	Application maturity evaluation of building steel structure welding robotic technology based on multi-level gray theory
16	2023	Pasparakis et al.	Assessing the impact of human–robot collaborative order picking systems on warehouse workers
17	2023	Berkers et al.	The role of robotization in work design: A comparative case study among logistic warehouses
18	2022	Sadangharn	Acceptance of robots as co-workers: Hotel employees' perspective
19	2022	Im and Kim	A study on hotel employees' perceptions of the fourth industrial technology
20	2022	Arslan et al.	Artificial intelligence and human workers interaction at team level: A conceptual assessment of the challenges and potential HRM strategies
21	2022	Parvez et al.	Antecedents of human-robot collaboration: Theoretical extension of the technology acceptance model
22	2022	Zhong et al.	Multi-stakeholder perspectives on the impacts of service robots in urban hotel rooms
23	2022	Khaliq et al.	Application of AI and robotics in hospitality sector: A resource gain and resource loss perspective
24	2022	Ogbeibu et al.	Green talent management and turnover intention: The roles of leader STARA competence and digital task interdependence
25	2022	Macpherson et al.	Industry 4.0: Emerging job categories and associated competencies in the automotive industry in South Africa
26	2022	Kim et al.	Delegation or collaboration: Understanding different construction stakeholders' perceptions of robotization
27	2022	Flechsig et al.	Robotic process automation in purchasing and supply management: A multiple case study on potentials, barriers, and implementation
28	2022	Del Giudice et al.	Humanoid robot adoption and labour productivity: A perspective on ambidextrous product innovation routines
29	2021	Anshari et al.	Developing talents vis-à-vis fourth industrial revolution
30	2021	Dixon et al.	The robot revolution: Managerial and employment consequences for firms
31	2021	Obashi and Kimura	New developments in international production networks: Impact of digital technologies
32	2021	Figueiredo and Pinto	Robotizing shared service centres: Key challenges and outcomes
33	2021	Cristina and Corneliu	Digital transformation of human resource processes in small and medium sized enterprises using robotic process automation
34	2021	Ding	Employees' challenge-hindrance appraisals toward STARA awareness and competitive productivity: A micro-level case
35	2021	Nankervis et al.	'Are we there yet?' Australian HR professionals and the fourth industrial revolution
36	2020	Cai et al.	Construction automation and robotics: From one-offs to follow-ups based on practices of Chinese construction companies
37	2020	Melián-González and Bulchand-Gidumal	Employment in tourism: The jaws of the snake in the hotel industry
38	2020	Grencikova et al.	Impact of Industry 4.0 on labor productivity in the Slovak Republic
39	2020	Xu et al.	How will service robots redefine leadership in hotel management? A Delphi approach
40	2020	Stein and Scholz	Manufacturing revolution boosts people issues: The evolutionary need for 'human-automation resource management' in smart factories
41	2020	Bonnaud and Bsiesy	Adaptation of the higher education in engineering to the advanced manufacturing technologies

(*continued on next page*)

Table A1 (*continued*)

No.	Year	Source	Title
42	2020	Jerman et al.	Transformation toward smart factory system: Examining new job profiles and competencies
43	2020	Chuang	An empirical study of displaceable job skills in the age of robots
44	2020	Ballestar et al.	Knowledge, robots and productivity in SMEs: Explaining the second digital wave
45	2019	Šimek and Šperka	How Robot/human orchestration can help in an HR department: A case study from a pilot implementation
46	2019	Bhattacharyya and Nair	Explicating the future of work: Perspectives from India
47	2019	Bogataj et al.	The ageing workforce challenge: Investments in collaborative robots or contribution to pension schemes, from the multi-echelon perspective
48	2019	Stanley and Aggarwal	Impact of disruptive technology on human resource management practices
49	2019	Lim and Lee	The policy challenge of high skills vocational education and training in the future social changes
50	2019	Fleming	Robots and organization studies: Why robots might not want to steal your job
51	2018	Gupta et al.	Automation in recruitment: A new frontier
52	2017	Grencíková and Vojtovic	Relationship of generations X, Y, Z with new communication technologies
53	2015	Gombolay et al.	Decision-making authority, team efficiency and human worker satisfaction in mixed human–robot teams
54	2014	Lindsay et al.	'Lean', new technologies and employment in public health services: Employees' experiences in the national health service
55	1990	Shenkar	Managing in a robotic age
56	1986	Chao and Kozlowski	Employee perceptions on the implementation of robotic manufacturing technology
57	1984	Knod et al.	Robotics: Challenges for the human resources manager
58	1984	Rosenthal	Progress toward the "factory of the future"
59	1982	Ayres and Miller	Robotics and conservation of human resources

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