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THE LEVELS OF ARTIFICIAL INTELLIGENCE APPLICATION IN HUMAN RESOURCE SYSTEMS[1]

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Abstract:
As human capital has become a vital asset in contemporary businesses, utilizing human resources exceeds HRM function towards strategic business partnership within organizations. The key enabling factor was global ICT development that changed functional roles and responsibilities within operating business models and introduced machine intelligence that increased organizational capabilities while reducing human involvement. The paper discusses the current state of AI applications in HRM systems. Emphasis is placed on clarifying technological features and goals, as well as the evolution of existing HRM systems. Furthermore, the paper provides the framework of AI application levels that serve as a foundation for understanding the current operational potential and provides useful evidence for the future development of HRM systems.

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INTRODUCTION

Human capital has become the most critical organizational asset (Đorđević-Boljanović *et al.*, 2019), especially in the era of the gig economy, cognitive computing and the appearance of the fifth industrial revolution (5IR), fueled by the development of blockchain technologies. Furthermore, with the emergence of the COVID-19 virus pandemic, which forcibly led to the change of previous work patterns, workforce demographics, business models and other socioeconomic circumstances, it is clear that human capital has never been more in the focus of contemporary „knowledge economy".

Large-scale development of artificial intelligence (AI) applications, brought a new dimension to human resource management (HRM), where the traditional approach has gradually been overcome and moved towards an intelligent (cognitive) approach within HRM (Ćormarković & Dražeta, 2022). Existing processes are becoming more agile, and some new ones are also appearing (Edlich *et al.*, 2019). In the near future, administrative, routine and repetitive jobs will be replaced by artificial intelligence applications/robots that are much more precise in performing certain operations (Smith & Anderson, 2014).

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However, analysis of existing research in the field of AI application in HRM showed a slight fear, as well as lack of understanding and clarity to what extent AI can be applied among existing business functions that employees use every day. In contrast, Jatobá *et al.* (2019) suggested a need for multidisciplinary working teams of technical engineers and HRM specialists, while Conchúir & Dražeta (2016) showed effective data leveraging process using cloud-based workflows shared between virtual teams due to contemporary technological advances. Hence, this paper attempts to review the existing state of the implemented AI applications and propose a framework for the levels of AI application in HRM systems.

AI: CONCEPT, SUBFIELDS AND TYPES

AI is a field of computing dealing with the development of a machine intelligence that mimic human cognitive functions such as understanding language, learning, reasoning, problem solving, planning, identifying patterns, and all the abilities that a human possesses (Das *et al.*, 2015).

In the past, AI developed through a number of subfields, such as robotics (intelligent control, autonomous exploration), computer vision (object recognition, image understanding), speech processing (speech recognition and production), Natural Language Processing (machine translation), neural networks (brain modelling), evolutionary computation (genetic algorithms, genetic programming), expert systems (decision support systems, teaching systems), planning (scheduling, game playing), machine learning (decision tree learning), etc. Today, we can use the generic term „artificial intelligence system", because contemporary robots combine all these subfields into one common system.

AI applications are currently used in a number of business domains, depending on the type of application software as well as the type of AI. There are several types of application softwares, namely interactive transaction-based applications, information systems, big data analytics systems (real-time or batch processing), sensor-based data collection systems (IoT applications), intelligent conversational systems (chatbots, personal assistant), embedded control systems, entertainment systems, stand-alone applications, etc. (Sommerville, 2016). In all of them, some sort of AI has been already implemented (e.g. machine learning algorithms, natural language processing).

Accordingly, AI can be also categorized into three distinct types (Wang & Siau, 2019; Stahl, 2021):

- Artificial Narrow Intelligence (ANI) or Weak AI. It is a goal-oriented type, designed to perform a singular task in order to solve a specific problem in a certain context. Today, ANI can outperform humans in some tasks, for example in analyzing substantial amounts of data. However, it cannot solve problems beyond the scope of its focus.
- Artificial General Intelligence (AGI) or Strong/Deep AI. The advent of deep learning (development of artificial neural network algorithms), which created a machine intelligence capable of performing general human intelligent actions with a full range of human cognitive abilities (e.g., humanoid robot Sophia).
- Artificial Superintelligence (ASI) or Machine consciousness. It can exceed general human intelligence across any task. However, there is a natural fear among the experts worldwide that such a type of superintelligence may represent a threat to humanity (Musikanski *et al.*, 2020).

HUMAN RESOURCES MANAGEMENT SYSTEMS

To grasp the level of AI applications implemented in HRM, at first, HR processes should be clearly established. Some processes are task- or transactional-oriented, but some are analytical, i.e. requires data analysis in order to make proper business decisions. In both cases, AI can be implemented, but in different ways. Hence, the goals and levels of AI implementations within existing HRM systems (i.e. information systems, web applications, big data systems), will be considered separately.

The overall purpose of HRM is to ensure the utilization of organizational human resources by creating, implementing and monitoring policies that govern employee relations within the organization. Hence, the objectives of HRM when developing AI applications can be divided into following four categories (Raymond *et al.*, 2021):

- **Social goals**: measures that correspond to ethical and social needs, including legal issues such as equal opportunities, equal wages, etc.
- **Organizational goals**: actions that ensure business efficiency, including training, equal distribution of jobs, retention of employees, etc.
- **Functional objectives**: guidelines used to maintain the proper functioning of human resources within the organization.
- **Personal goals**: resources used to support each employee's career, including personal development, maintaining employee engagement, etc.

Human Resource Management systems: from traditional to intelligent

Generally, the first type of HRM system that had been widely used within companies was the information system (IS). Database, processes, interfaces, networks, technologies and people who develop and maintain them are the core components that distinguish IS from other applications (Njeguš, 2021). Traditional information systems, that support an organisation's day-to-day business activities, were usually built on top of a relational database (DB).

This type of HRM system is often a module of larger information systems, called Enterprise Resource Planning (ERP) systems. ERP is a holistic IS that integrates key business processes within the company, such as finance, marketing, human resources, manufacturing, and warehouse management. Some of the leading information systems on the market are SAP ERP, Microsoft Dynamics 365, Oracle ERP, Sage and others (Gartner, 2022).

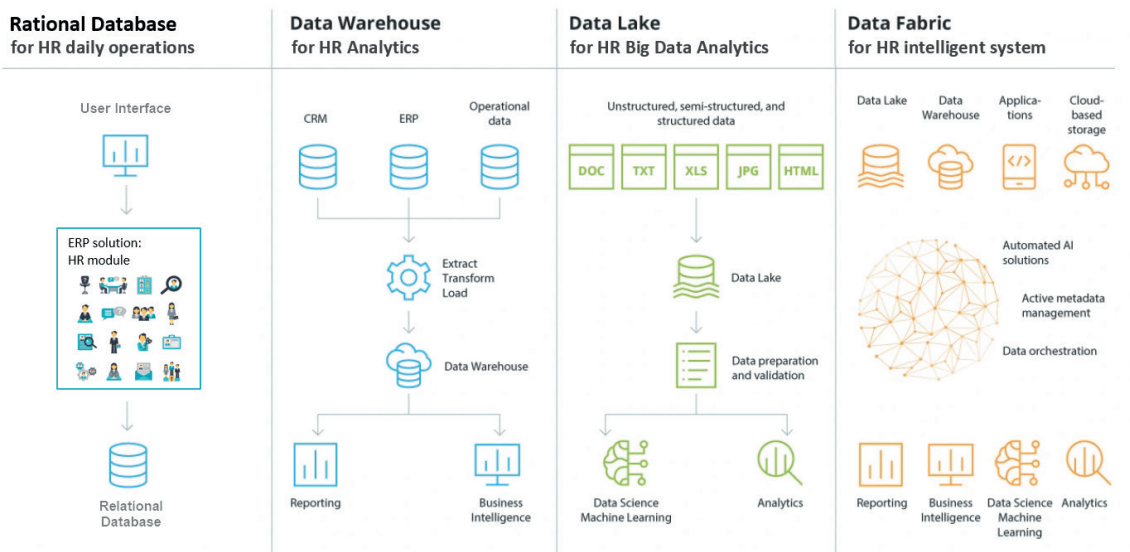
In contrast, most of the HRM processes are incorporated into the HRM module of ERP systems. For example, SAP HCM (Human Capital Management) covers number of submodules such as Organizational management, Personnel management, Time management, Payroll Accounting, Travel management, etc. Today SAP boosts its core processes with AI, especially with machine learning algorithms.

With the development of the analytical type of information systems, called Business Intelligence (BI) systems, the HRM is expanded with human resource analytics (Margherita, 2022; McCartney & Fu, 2021). Human resource analytics systems are built on top of a data warehouse (DW), which is a distinct type of database (Njeguš, 2021). DW are designed to perform multidimensional queries (i.e. OLAP cubes) and analysis of large amounts of historical data (Figure 1).

The advent of IoT and Big data devised a new type of application software able to process a lot of data presented in different formats (image, video, voice, text), and in real-time. Namely, data generated today on the Web and IoT devices, require new technologies to process such sizable volumes (e.g. Hadoop ecosystem). Type of application that processes data for HRM, is named HR Big Data systems with a database called a Data lake (Holwerda, 2021). The power of Big Data is used by applying some machine learning algorithms to the data extracted in real-time from various sources and placed on computer clusters to be visually displayed to the end user. Consequently, the whole process of extraction, cleaning and normalization of data, reduction of data dimensionality, and application of machine learning algorithms is known as Data Science. In contrast, HR web and smart applications based on machine learning algorithms have appeared on the market, and usually cover only one specific HRM process (García-Arroyo & Segovia, 2019).

With recent development of blockchain algorithms and newer generations of machine learning algorithms, the so-called deep learning (set of artificial neural networks), in 2021 new type of database known as Data fabric, was created, where all data can be processed, managed, and stored as it moves (i.e. when there is a need). As presented in Figure 1, Data fabric continuously identifies and connects data from disparate applications, therefore connecting multiple locations, types, and data sources (Gupta, 2021).

Figure 1. Comparison of different types of databases for HRM systems (modified from Kyslyi, 2022).



LITERATURE REVIEW

Analysis of publications in the field of AI applications in HRM showed two distinct paths of research. One path is dealing with the implementation of machine learning in a specific HRM domain, by showing what algorithms give the best results for a certain HRM process. The other path analyses the level of AI applications in HRM functions within companies, which corresponds to the objective of our paper. Table 1 shows most recent preview of the second path of research.

Table 1. Review of the latest scientific research papers in the field of AI applications in HRM

Authors	Title of paper	Research description	Research results
Cappelli *et al.* (2018)	Artificial intelligence in HRM: Challenges and a path forward	The gap between the promise and reality of AI in HRM is analysed. Specifically, ML algorithms were taken into the analysis.	Four challenges are identified: the complexity of HR, small data sets, ethical questions associated with fairness and legal constraints and employee reactions to AI management.
Jatobá *et al.* (2019)	Evolution of Artificial Intelligence Research in Human Resources	Analysis of existing research in the area of ANNs application in HRM topics, for the period 2000-2018.	There are just a few types of research on AI applied to HRM, there is a need for multidisciplinary teams, i.e. technical engineers and HRM specialists.
Niehueser & Boak (2020)	Introducing Artificial Intelligence into a Human Resources Function	Empirical research on factors affecting the introduction of AI on the talent acquisition function.	Three main factors emerged: increase in efficiency, better performance and quality of the AI applications, and easy to use.
FraiJ & László (2021)	A Literature Review: Artificial Intelligence Impact on the Recruitment Process	Analysis of AI implementation in the HRM recruitment processes.	AI can boost the process of identifying talents, facilitate dealing with a huge number of applicants, eliminate any bias attempts, etc.
Vrontis *et al.* (2021)	Artificial Intelligence, Robotics, Advanced Technologies and Human Resource Management: a Systematic Review	Understanding the impact of intelligent automation technologies utilization in HRM, both at organizational and employees level.	The impact of these technologies concentrates on HRM strategies, namely, job replacement, human-robot/AI collaboration, decision-making and learning opportunities, as well as HRM activities, namely, recruiting, training and job performance.
Garg *et al.* (2021)	A Review of Machine Learning Applications in Human Resource Management	Identify the degree, scope and purposes of machine learning (ML) adoption in the core functions of HRM.	ML applications are strongest in the areas of recruitment and performance management, while the use of decision trees and text-mining algorithms for classification dominate all functions of HRM.

Authors	Title of paper	Research description	Research results
Jaiswal *et al.* (2021)	Rebooting Employees: Upskilling for Artificial Intelligence in Multinational Corporations	Taking into account the dynamic skill, neo-human capital and AI job replacement theories, based upon interviews of 20 professionals in IT companies.	Research revealed five critical skills for employee upskilling: data analysis skills, digital skills, complex cognitive skills, decision-making skills and continuous learning skills.
Hemalatha *et al.* (2021)	Impact of Artificial Intelligence on Recruitment and Selection of Information Technology Companies	Analyze the impact that AI is having on recruitment and selection. An online survey of 141 IT employees was conducted.	AI technologies capabilities such as NLP, Machine Vision, Automation, and Augmentation have positive outcomes on time & cost-saving, accuracy, removing bias, reducing workload, increasing efficiency, and candidate experience.
Chowdhury *et al.* (2022)	Unlocking the Value of Artificial Intelligence in Human Resource Management through AI Capability Framework	A systematic review of the literature in order to provide an objective understanding of the organisational resources required to develop AI capability in HRM.	To benefit from AI adoption, the authors proposed an AI capability framework for the managers to objectively self-assess organisational readiness and develop strategies to adopt and implement AI-enabled practices and processes in HRM. They suggest that organisations need to look beyond technical resources and emphasise on human skills and competencies, leadership, team coordination, organisational culture and innovation mindset, governance strategy, and AI-employee integration strategies.
Bärmann, (2022)	Trust in Artificial Intelligence in Human Resources Development	AI processed data in an organizational context leaves employees vulnerable. Besides their dependence on trusting the managers with their competences and intentions, they also depend on AI to produce credible and meaningful data.	Research identifies the critical variables of trust in the relationship among an employee, the AI used and the manager. The result is a new integrative model of trust in AI, based upon organizational trust extended by aspects of initial trust and FEAS (fairness, explainability, auditability, and safety) elements of AI trustworthy. In the future, employees' perspectives should be more considered.

THE LEVELS OF AI APPLICATIONS IN HRM SYSTEMS

In general, the level of modern technology applications in companies primarily depends on the real needs of employees, the issues and challenges they face, the readiness and feasibility of new technologies introduction and the requirements aimed at achieving better performance and competitiveness (Njeguš, 2021). An interesting fact is that professionals often blame IT experts for the rapid development of information technologies, but this responsibility lies upon end-users. The development (IT) team is only dealing with the growing number of end-user requests while trying to find a long-term sustaining solution. However, responsibility for creation of innovative solutions to address end-user problems, is primarily on IT team.

According to the literature reviewed, HRM does not fully use the power of AI, but still relies on already proven information systems within the company. In order to grasp the current state of existing HRM systems, possibilities of technical upgrade, and type of missing AI applications relevant for business, the framework of AI applications levels in HRM systems is proposed (Table 2).

Not every part of HRM process is critical for the business, strategy, and profitability of the company, so the first step is to analyze core HRM processes. For example, balanced scorecard (BSC) can serve as a metric for defining key HRM indicators that support the company's strategic business goals. According to data on HRM processes, the strategic HRM information system should be acquired. This is quite important since employees are using only 20% of software functionalities, while 50% are hardly ever or never used, and about 30% are used sometimes or rather infrequently (Njeguš, 2021).

The levels of current AI applications in HRM systems are explained in more detail below.

First level: Intelligent Automation

Nowadays, almost every company is using some sort of application software. The core business is usually covered by some ERP business solutions. However, companies also have deployed other types of applications, such as CRM (Customer Relationship Management), web/mobile applications, and others. All these systems should work together in an interoperable way i.e., to exchange and process data in coordinated fashion. The HRM department uses either an HR module within an ERP solution, certain Human Resource Information System (HRIS) or some other HRM applications (Njeguš, 2021). When using these traditional systems, tasks are usually repetitive, tedious, predictable, and labor-intensive.

Table 2. The framework of AI application levels in HRM systems

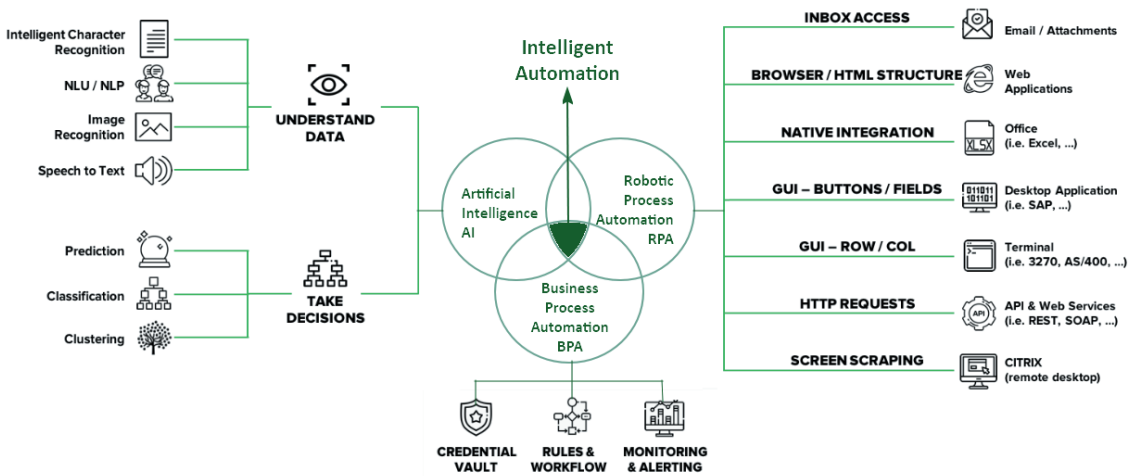
AI type	Levels of AI	Traditional systems	Focus on	With embedded AI
ARTIFICAL NARROW INTELLIGENCE	1. Intelligent automation	System types: ERP HR Module, HR information system (HRIS), HR web applications, HR legacy system or other.	Processes	Implementation of RPA and AI into traditional systems in order to achieve HRM intelligent automation systems.
		DB type: Relational database		
		Transactions processed: online		
		Analytics type: Reports		
	2. Smart Analytics Systems	System types: HR Business Intelligence (BI) system, HR Analytics Information System, HR OLAP System, HR Data Mart or other.	Decision making	Implementation of ML algorithms for advanced HR Analytics.
		DB type: Data Warehouse		
		Transactions processed: batch		
		Analytics type: OLAP cubes, data mining algorithms, visualization of KPI		
	3. Big Data AI Systems	System types: Big Data Analytics systems, Big Data Conversational Systems.	Real-time	Implementation of computer vision, NLP, processing and pattern recognition in speech, image, video, text, deep learning algorithms and other AI fields.
		DB type: Data Lake		
		Transactions processed: real - time		
		Analytics type: ML algoriths		
ARTIFICIAL GENERAL INTELLIGENCE	4. Intelligent systems (applications or robots) with human capabilities	System types: Chatbots, Personal Assistant, Robots	Complete (general) AI system	Implementation of affective computing and advanced robotics.
		DB type: Data Fabric		
		Transactions processed: streamline		
		Analytics type: ML with a focus on Deep Learning algorithms		

RPA (Robotic Process Automation) bots can tackle data entries, generate reports, alert, and do other rule-based tasks (Asatiani *et al*., 2022). Pure RPA (without AI) is a rule-based, process-driven software application that processes structured data with deterministic outcomes with no elements of intelligence (e.g., automated form filling). Therefore, RPA is not considered a part of AI (Herm *et al.,* 2022). However, RPA bots may combine RPA core functions with AI elements and are primarily designed to emulate human actions and judgment, more quickly and with fewer errors (Mohamed *et al*., 2022). In general, there are three types of RPA bots: Programmable, Self-learning and Cognitive (intelligent) automation bots (Houy *et al*., 2019). Intelligent automation is a fusion of different technologies including RPA

and AI where RPA automate tasks and processes, and intelligent automation creates smarter business processes and workflows, identifies patterns, and learns from previous actions in order to improve processes, provides analytics and decision-making, adapts to their own and self-manages (Figure 2) (Madakam *et al.*, 2022; Chugh *et al.*, 2022).

Some HRM processes, such as recruitment and onboarding, contain numerous repetitive and rules-based tasks that RPA can assist with. RPA bot can source applicants with more accuracy and no bias, screen CVs and handle much of the paperwork that HRM staff is responsible for. Hence, RPA in HRM function can be applied to CV screening and shortlisting candidates, background verification for new hires, onboarding new hires, employee induction and training, employee data management, payroll processing, expense management, maintaining compliance, employee exit management, performance management, calculation of shift allowance, tracking attendance, etc. (Dilmegani, 2022). Available intelligent automation platforms are IBM Cloud Pak, Automation Anywhere, BluePrism, UiPath, CAI, NexBotix, CGI and other.

Figure 2. Intelligent Automation Components (modified from Reply, 2022)



Second level: Smart Analytics Systems for Decision Makers

The first level of AI applications supports and improves day-to-day business operations and are used by each employee. The second level of AI applications is intended for decision-makers, regardless of their level of hierarchy in business (i.e., operational, tactical, or strategic). These traditional systems are known by different names, such as Business Intelligence systems, Analytical information systems or just OLAP (On-Line Analytical Processing) systems. They are developed on top of the Data Warehouse, to which either OLAP cubes (multidimensional queries) or data mining models were originally applied. Today these systems are extended with other ML algorithms and have become an integral part of Big Data Analytics systems (e.g. Hadoop ecosystem) (Kakulapati, 2020).

The advantage of these systems is the visualization of Key Performance Indicators (KPIs) that focus on the most important performance measures that quantify objectives and enable the measurement of strategic performance (Huselid, 2018). HRM KPIs are typically stored in the HR Data Mart, which is

a partitioned segment of an enterprise data warehouse aligned with the HRM department. Therefore, HRM professionals are using HR data mart for querying, reporting, visualizing, as well as running advanced analytical techniques for clustering, classification, segmentation, and prediction to make better decisions (Hamoud *et al*., 2020).

Some key features of the human resource analytics systems are workforce analytics, employee turnover forecasting, recruitment analytics etc. For example, if the objective is to reduce turnover costs, the key performance measures may include cost-per-hire, turnover rates and costs, time-to-fill, new-hire satisfaction with orientation, supervisor satisfaction with orientation (learning and growth) and others. The aforementioned traditional systems, where data mining algorithms were applied for data analysis, have been recently upgraded with modern ML algorithms that enable more advanced analytics with greater precision in providing proper knowledge to decision makers (Ćormarković & Dražeta, 2022). Therefore, this level of AI applications is mostly based on ML algorithms implementation. Available HR Analytics solutions today are SageHR, IBM Cognos Analytics, BambooHR, IntelliHR, etc.

Third level: Big Data AI Systems

The key characteristics of Big Data Analytics systems, as compared with the traditional structured systems, are that they can process different data formats (image, voice, video, text, etc.), in real-time, while generated at high velocity on different platforms (IoT, Web, browsers, etc.). Traditional technologies are not able to cope with big data, because they are primarily intended for processing structured data. Furthermore, due to the physical limits of data storage, they are unable to process a huge amount of data in real-time. Therefore, newer technologies appeared, such as NoSQL database systems, the Hadoop ecosystem, and others.

Analytical Information Systems or Business Intelligence (BI), have their data extracted, refined (transformed into a consistent, highly structured format), and then loaded into the data warehouse. In contrast Big Data systems, also have their data extracted but immediately loaded into the Data Lake. After that, if necessary, data get transformed while ML algorithms and other relevant AI fields are applied.

Today, big data systems have surpassed traditional systems and companies often acquire them in the form of smaller web applications that manage some of the key HRM processes currently available on the market. More companies are developing these systems from scratch for their specific needs. Today, these systems are upgraded by incorporating missing HRM processes, newer indicators for business monitoring and analysis, and in support they get expanded with other ML algorithms.

Some of the advantages of Big Data systems over the traditional structured systems is that information placed anywhere in any data format is immediately visible to interested parties, analytics are updated in real-time, and decision-makers are warned about opportunities or threats so they can react promptly. For example, the Big Data system can analyze big unstructured data from annual surveys, web profiles, social media chatters, and other data sources on the internet.

An increasing number of evidence shows big data use in HRM processes such as recruiting the best talent, prioritizing recruitment channels, streamlining the hiring process, improving employees' motivation and engagement, resource utilization and employee retention, enhancing learning and development, detecting employees' health and injuries, future forecasting for HRM strategy improvement and avoiding subsequent issues in hiring, retention, and performance. Currently available web applications that use the power of ML and analysis of big data extracted from various sources (most often from social media) are: Peoplise solution for applicant tracking and assessment; PhenomPeople solution,

LinkedIn and Glassdoor for attracting talent; Glint Employee Engagement platform for attrition detection; Workday solutions for individual skills management, personalized training recommendations according to company's needs, market trends, and employee specifics, and performance development.

Fourth Level: Intelligent Systems (applications or robots) with human capabilities

This type of AI system, known as Strong/Deep AI, is still under the development. This system can apply its intelligence in solving complex problems almost as humans do, such as recognizing emotions, beliefs, and mental processes and utterly understand all human aspects, rather than only replicating or simulating the human mind. The first attempt of such intelligent system is the robot, Sophia. However, Sophia's mindset is still in infancy, and far from being AGI type (Lopes & Alexandre, 2018; Acharjee, 2022). When this type of AI system gets developed, robots may appear in the business environment, working side by side with humans (Johnson, 2019). The role of employees may get changed, for example, training machines to perform certain tasks, explaining the outcomes and sustaining the further responsible use of machines (Wilson & Daugherty, 2018).

In addition to robotics, the accelerated development of intelligent applications should not be neglected, namely towards AGI-type AI. Today, these applications are mostly in the form of conversational AI systems, such as chatbots and personal assistants (Gao *et al.*, 2018). Current examples of these applications are Microsoft Azure Bot Services and Cognitive Services, SAP Conversational AI, IBM Watson, Dialog Flow by Google, Amazon Lex, Rasa, etc.

CONCLUSIONS

The implementation of AI in nowadays HRM systems is more than just an advanced technology employment. The advents of machine intelligence that mimic human cognitive functions and all the abilities that humans possess, necessitate a shift from traditional to intelligent approach in HRM services. It provided numerous advantages for human resource professionals, evolving from ERP systems to Deep Learning that enable greater focus on a number of HRM processes such as employee relations, personal growth, career development, etc., in ever growing business environment.

This paper presents the latest scientific research in the field of AI applications in HRM. The concept, subfields and types of AI were explained in order to clarify critical HRM goals when developing AI applications. The body of presented evidence revealed "state of the art" in the field of AI applications in HRM and the genesis of contemporary HRM information systems worldwide. Consequently, the framework of proposed AI application levels in HRM provides both human resource professionals and IT developers with a foundation for operational utilization of current systems (tailored to business needs and environment) and remarks for further development of intelligent information systems.

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NIVOI PRIMENE VEŠTAČKE INTELIGENCIJE U SISTEMIMA LJUDSKIH RESURSA

Rezime:

Kako je ljudski kapital postao dragocena prednost u savremenom poslovanju, korišćenje ljudskih resursa prevazilazi funkciju upravljanja ljudskim resursima u okviru strateškog poslovnog partnerstva unutar organizacija. Ključni faktor koji je to omogućio je globalni razvoj IKT-a koji je promenio funkcionalne uloge i odgovornosti u okviru operativnih poslovnih modela i uveo mašinsku inteligenciju koja je povećala organizacione sposobnosti uz smanjenje ljudskog učešća. U ovom radu se razmatra trenutno stanje aplikacija koje koriste veštačku inteligenciju u sistemima za upravljanje ljudskim resursima. Akcenat je stavljen na objašnjenje tehnoloških karakteristika i ciljeva, kao i na razvoj postojećih sistema upravljanja ljudskim resursima. Štaviše, rad daje okvir različitih nivoa primene veštačke inteligencije koji služi kao osnova za razumevanje trenutnog operativnog potencijala i pruža korisne informacije za budući razvoj sistema upravljanja ljudskim resursima.

Ključne reči:
Veštačka inteligencija,
Mašinsko učenje,
Upravljanje ljudskim resursima,
Informacioni sistemi,
Nivoi aplikacija koje koriste veštačku inteligenciju.