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THE FEATURES OF ORCHESTRATION FOR MULTI-AGENT ARTIFICIAL INTELLIGENCE SYSTEMS APPLIED TO THE TASKS OF HR PROCESS AUTOMATION IN IT COMPANIES

An urgent challenge of the present day is integrating traditional managerial decision-making with artificial intelligence technologies to achieve optimized organizational advantages. Human resource management supported by artificial intelligence enhances the efficiency of selecting software developers in IT companies. Global practice in the development and application of artificial intelligence in recruitment processes demonstrates a steady shift away from traditional forms of personnel management amid societal digitalization. The rapid increase in the volume of data on candidates for vacant positions, the need for swift responses to changes in the IT labor market, and rising demands for personalized interactions create a foundation for utilizing agent coordination as a tool for improving HR management effectiveness.

This study analyzes the key components of orchestration: role distribution among agents, synchronization of their behavior, selection of optimal communication protocols, as well as ensuring transparency and reproducibility in managerial decision-making. A comprehensive orchestration model is proposed, incorporating the full life cycle of HR processes—from sourcing and screening candidates to onboarding, performance evaluation, and employee development management. It is demonstrated that the integration of specialized agents (resume-analysis agents, job-fit prediction agents, team-interaction modeling agents, and communication agents) significantly reduces traditional operational workloads, increases selection accuracy, and enables scalable HR functions.

The conducted analysis shows that competent orchestration of AI-based multi-agent systems not only automates routine processes but also establishes the foundation for developing adaptive, context-sensitive HR ecosystems capable of supporting the strategic goals of IT companies within a dynamic digital society.

Keywords: multi-agent systems, artificial intelligence, large language models, digital society, human resource management, automated selection of software developers

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ОСОБЛИВОСТІ ОРКЕСТРАЦІЇ МУЛЬТИАГЕНТНИХ СИСТЕМ ШТУЧНОГО ІНТЕЛЕКТУ ДЛЯ ЗАДАЧ АВТОМАТИЗАЦІЇ HR-ПРОЦЕСІВ В IT-КОМПАНІЯХ

Актуальною проблемою сьогодення є інтеграція традиційних управлінських рішень з технологіями штучного інтелекту, що призводить до оптимізації організаційних переваг. Управління персоналом з застосуванням штучного інтелекту оптимізує підбір програмістів для IT-компаній. Світова практика розвитку та використання штучного інтелекту в процесах рекрутингу демонструє тенденцію до зміни традиційних форм управління персоналом в умовах цифровізації суспільства. Стрімке зростання обсягів даних про кандидатів на вакантні посади, необхідність швидкого реагування на зміни IT-ринку праці та підвищення вимог до персоналізованих взаємодій формують підґрунтя для використання координації агентів як інструменту підвищення ефективності управління персоналом. У роботі аналізуються ключові компоненти оркестрації: розподіл ролей між агентами, синхронізація їх поведінки, вибір оптимальних протоколів комунікації, а також підтримка прозорості та відтворюваності прийняття управлінських рішень. Запропоновано модель оркестрації, що враховує життєвий цикл HR-процесів - від пошуку та скринінгу кандидатів до онбордингу, оцінювання продуктивності та управління розвитком співробітників. Показано, що інтеграція спеціалізованих агентів (агентів аналізу резюме, прогнозування відповідності, моделювання командної взаємодії, комунікаційних агентів) забезпечує суттєве зниження традиційних операцій, підвищує точність відбору та створює умови для масштабування HR-функцій. Проведений аналіз демонструє, що компетентна оркестрація МАС ШІ дозволяє не лише автоматизувати рутинні процеси, але й формує основу для побудови адаптивних, контекстно чутливих HR-екосистем, здатних підтримувати стратегічні цілі IT-компаній у динамічному цифровому суспільстві.

Ключові слова: мультиагентні системи, штучний інтелект, великі мовні моделі, цифрове суспільство, управління персоналом, автоматизований підбір програмістів

Formulation of the problem in a general form
and its connection with important scientific and practical tasks

In contemporary research, significant attention is often given to the idea that the implementation of innovative technologies, particularly artificial intelligence, will foster sustainable development. However, such discussions frequently overlook the human resources required to achieve these outcomes. Digital human resource management remains insufficiently explored despite its need for effective planning of workforce engagement, reskilling, and upskilling initiatives. Comprehensive studies that integrate artificial intelligence, human resource management, and sustainable development as interrelated domains are still at an early stage of development.

Recent advances in artificial intelligence technologies and the active adoption of multi-agent architectures in business processes have the potential to modernize automation in HR management within IT companies. Modern HR processes: recruitment, onboarding, competence assessment, development planning, and performance management are characterized by high variability, large data volumes, and the necessity for rapid responses to dynamic changes in project requirements. At the same time, traditional HR automation tools lack sufficient flexibility and are unable to support personalized managerial decision-making.

Artificial intelligence–based multi-agent systems (MAS), in which different specialized agents perform distinct functions (search and selection of candidates for IT positions, competence analysis, prediction of turnover risks, generation of recommendations for training and upskilling, etc.), demonstrate substantial potential for increasing the efficiency of HR processes. However, their successful application directly depends on the quality of orchestration, that is, the alignment of agent actions, distribution of roles, coordination of inter-agent communication, assurance of result integrity, and minimization of decision-making conflicts. Despite the active development of multi-agent platforms and frameworks, the problem of effective agent orchestration within the HR domain remains insufficiently explored. In particular, there are no established approaches to:

- adaptive management of agent interactions under conditions of uncertainty and rapidly changing business requirements;
- integration of agents oriented toward processing personnel-related information;
- construction of scalable architectures capable of simultaneously performing multi-level HR tasks;
- evaluation of orchestration quality in terms of accuracy, performance, reliability, and its impact on managerial decision-making in HR.

Multi-agent systems are becoming increasingly popular because a single agent is not always capable of:
- simultaneously planning, executing, and controlling tasks;
- handling highly diverse problem types;
- possessing specialized competencies required for each subtask.

Orchestration enables the development of complex AI systems in which:
- each agent is specialized;
- the system remains flexible and scalable;
- the output is stable and of high quality.

In traditional HR processes, it is generally possible to reconstruct the reasoning of a recruiter or manager; however, when an orchestrated MAS is employed, in which multiple agents transform and aggregate information in different ways, it becomes difficult to determine which specific component contributed to the final decision. This increases the requirements for explainable AI (XAI) mechanisms, audit trails, agent action logging, and procedures of both external and internal audits.

Thus, an urgent problem is the development and investigation of orchestration approaches for AI-based multi-agent systems tailored to the specifics of HR processes in IT companies, intending to increase the efficiency of human resource management, reduce routine workloads for HR specialists, and ensure transparency and justification of decision-making. Solving this problem will contribute to the formation of new models of intelligent automation and the creation of high-performance HR ecosystems within the digital society.

Analysis of research and publications

The study [1] contributes to the digitalization of strategic human resource management (SHRM) and, accordingly, to the transformation of operational practices in IT companies, where digital HR management becomes a mechanism for building a sustainable, flexible, and adaptive organizational ecosystem. Modern SHRM integrates technologies, business process transformation, and a focus on sustainable competitive advantage, positioning HR as an integrator between strategy, organizational culture, and digital innovation. This is particularly important for IT companies, as technological changes, new frameworks, development paradigms, and architectures directly depend on the quality and flexibility of teams, their capacity for learning, and the rapid renewal of competencies.

The stage of digital recruiting 2.0 is associated with the emergence of large commercial platforms and job boards such as Indeed, Monster, and similar resources. During this period, electronic résumés become standardized, the use of search filters, recommendation algorithms, and candidate databases becomes widespread [2], and the first models of HR data analytics are formed: companies begin to track hiring funnel conversions, sources of the most effective candidates, and the average time needed to fill vacancies.

The stage of digital recruiting 3.0 is characterized by the extensive introduction of artificial intelligence, machine learning, and big data into human resource management practices. According to the review [3], digital recruiting evolves from simple online vacancy posting to comprehensive systems that employ algorithms for résumé screening, automated

interviews, analysis of candidates' behavioral patterns, and vacancy text optimization. IT companies increasingly view artificial intelligence as a key tool for managing large streams of applicants for various positions.

In addition, digitalization encompasses other areas of HR management, including performance management, learning and development, compensation and benefits, career planning, and engagement management. Integrated HRIS/HRMS systems, talent management systems, and analytical platforms are being developed to ensure end-to-end processing of HR data from recruitment to offboarding. Thus, artificial intelligence is gradually penetrating all functions of the HR cycle, forming a new paradigm of "AI-enabled HRM." AI-oriented approaches make it possible to forecast the risk of turnover among key employees, assess the impact of changes in compensation policy on engagement, and model the consequences of various restructuring or team-scaling scenarios [4].

Within this process, the importance of the HR triad, the interaction between employees, line managers, and HR professionals, grows significantly. Study [5] demonstrates that the implementation of AI not only redistributes operational work among these actors but also transforms their roles: part of the classical HR functions becomes automated, while the need for analytical, advisory, and orchestration competencies increases. The HR specialist becomes an "architect" of digital solutions for personnel management, whereas the line manager becomes an active user of HR analytics and AI-based recommendation systems.

Thus, automation currently extends beyond isolated tasks and evolves into a holistic intelligent orchestration of HR processes. Contemporary studies on AI adoption in HR demonstrate that such systems can significantly reduce time-to-hire, improve selection accuracy, and ensure more consistent decisions than traditional approaches, provided that they are designed appropriately and grounded in high-quality data [4]. At the same time, these systems introduce a new level of managerial complexity, namely, the need to synchronize agents, define prioritization rules, manage conflicts among recommendations, and monitor the quality and fairness of decisions.

A critical issue concerns responsibility: who is accountable for a discriminatory decision - the model developer, the platform provider, the HR specialist who applied the system, or the manager who approved the policy? The answer to this question largely depends on how the digital architecture of HR processes is constructed: whether there is a human-in-the-loop, whether the system operates autonomously, and whether mechanisms for contesting and reviewing decisions are provided. Contemporary studies on AI ethics within the HR domain advocate transitioning toward models in which a multi-agent system does not replace the human decision-maker but serves as an instrument for multidimensional analysis, with the final decision assigned to a responsible actor [6].

Multi-agent systems (MAS) enhanced with embodied artificial intelligence are referred to as embodied multi-agent systems (EMAS). Despite growing interest in this field, a comprehensive review of EMAS remains insufficient. The study [7] proposes an analysis and synthesis of EMAS from a managerial perspective, conceptualizing each embodied agent as an entity equipped with a "brain" for decision-making and a "body" for interacting with the environment.

Modern multi-agent systems have evolved into distributed networks of agents, which, in turn, influence industrial applications and stimulate research into the development of several integrated frameworks. Digitalization enables digital twin technologies to analyze production indicators in real time and to predict potential outcomes. This allows managers to obtain real-time decision support and assess potential risks instantaneously [8].

However, reliance on artificial intelligence simultaneously raises concerns about the amplification and propagation of human biases embedded in hiring algorithms, which has been empirically demonstrated through biased candidate-rating systems and automated interview assessment tools [9].

The study [10] proposes a multi-agent platform for resume screening using LLMs (large language models) to systematically process and evaluate candidate resumes. Resume screening is a labor-intensive stage of recruitment that requires recruiters to analyze a vast number of job applications while maintaining objectivity. With the advancement of LLMs, reasoning capabilities, and extensive knowledge bases introduce new opportunities for optimizing and automating recruitment workflows.

The work [11] emphasizes that although academic output in the field of intelligent automation is rapidly growing, a comprehensive understanding of the impact of these technologies on human resource management (HRM) at both the organizational (firm-level) and individual (employee-level) dimensions is still lacking.

Strategically, AI is transforming HR from a reactive service function into a proactive, data-driven partner aligned with a company's long-term objectives. The study [12] demonstrates that successful integration of artificial intelligence depends on governance mechanisms that adhere to ethical standards, foster employee trust, and ensure transparency, enabling organizations to fully realize the potential of AI for improving human resource management.

The conceptual work [13] examines the intersection of artificial intelligence, human resource management, and the circular economy, demonstrating digital resilience and organizational transformation. Study [14] emphasizes that despite growing research interest, investigations of AI-based technologies for HRM remain limited and fragmented. Further research is required to analyze the role of AI-driven applications within HRM functions and the dynamics of human AI interaction in large multinational enterprises that disseminate such innovations.

Scholars [15] note that limitations typically arise during the adaptation of artificial intelligence in personnel management due to the complex nature of HR-related phenomena and the constraints of small datasets.

The present study continues the authors' previous research in the field of developing and applying advanced information technologies, including artificial intelligence, for the task of ranked selection of software developers in IT companies [16–19].

Formulation of the aims for the article

The aim of this study is to develop an orchestration model for an artificial intelligence–driven multi-agent system that integrates the key stages of the HR process lifecycle in IT companies: sourcing and screening of candidates, technical and behavioral assessment, onboarding, performance analytics, and the management of employee training and development. The objective of the proposed model is to ensure coherent interaction among specialized agents, enhance the accuracy of HR decision-making, and minimize temporal and operational costs.

Main text presentation

Currently, in IT companies, the application of multi-agent systems (MAS) deserves particular attention, as they enable the modeling, automation, and orchestration of complex HR processes. On the other hand, the multi-agent approach in HR generates a number of unresolved theoretical and practical challenges. First, it is necessary to formalize orchestration mechanisms for agents that may operate in parallel, compete for resources, or require strategic coordination. Second, the scalability and adaptability of such systems demand the development of efficient models of memory, context processing, data exchange, and knowledge management. Third, the implementation of MAS in real HR environments is associated with integration into corporate HRIS, ERP, ATS, and other systems, which introduces additional requirements for interoperability, security, and the management of confidential information.

In modern systems based on large language models (LLM), the concept of an agent is significantly expanded: an agent may possess a complex internal knowledge model (via the LLM), have access to external tools (APIs, databases, web services), maintain long-term memory (through vector stores), and implement complex reasoning patterns (chain-of-thought reasoning, planning, self-reflection, etc.).

In the context of HR processes in IT companies, an agent can be interpreted as a "digital employee" with a clearly defined role: candidate sourcing agent, resume semantic analysis agent, technical interview agent, competence assessment agent, onboarding planning agent, turnover-risk analysis agent, and so forth. Each of these agents operates on its own subset of data, applies its own analytical methods, and interacts with other agents through formalized protocols of message exchange, queries, and event-driven communication.

An agent in a MAS "understands" the context of its activity and can participate in collective planning and coordination of actions. This is critically important for complex HR scenarios, where decisions are formed at the intersection of technical, organizational, and ethical factors. To formalize a multi-agent architecture, it is appropriate to distinguish several dimensions of agent classification:

By role within the system, the following classification may be introduced:

- domain agents (perform domain-specific tasks: resume analysis, candidate ranking, preparation of interview scripts);
- infrastructure agents (manage logging, monitoring, security, and configuration management);
- orchestrators/managers (decompose complex tasks into subtasks, distribute them among agents, and aggregate results);
- teacher-agents and supervisor-agents (ensure the quality of other agents' decisions, initiate re-evaluation, calibrate criteria).

Within the HR domain, openness is an essential property, since IT companies constantly modify their tool stack, connect new data sources (job platforms, professional social networks, internal knowledge bases), and introduce new business processes.

Theoretically, we consider a MAS as a triple:

$$\{ A, E, I \},$$

where (A) denotes the set of agents, (E) represents the shared environment (or a set of environments), and (I) refers to the set of interaction protocols.

The environment (Environment) in the case of HR processes in IT companies includes:

- candidate databases (Applicant Tracking Systems - ATS);
- corporate HRIS/HRMS containing information on employees, their roles, contracts, and performance history;
- external data sources (LinkedIn, GitHub, job boards, educational platforms);
- knowledge management systems (Confluence, Notion, internal documentation repositories);
- business applications (CRM, project management systems, billing systems, support systems).

Orchestration in the context of a MAS is the process of coordinating the actions of multiple agents in order to achieve the global objectives of the system under conditions where individual agents possess their own (partial) goals, constraints, and informational perspectives.

Orchestration requires a clear definition of which agents, and in which scenarios, are authorized to read or modify specific segments of the shared memory. For example, a recruiting agent may be granted access to anonymized employee performance histories but not to personal medical data; an analytics agent may operate with aggregated metrics rather than individual profiles without additional permissions. Thus, memory management mechanisms are inseparable from architectural decisions related to security, privacy, and compliance with regulatory requirements (GDPR, local labor legislation).

Context management is equally important: each request to an agent must be accompanied by a sufficient but not excessive amount of information. In LLM-based agents, this is reflected in prompt construction and Retrieval-Augmented Generation strategies. The orchestrator must determine:

- which contextual fragments are necessary for a specific agent;
- which parts of the context should be concealed according to the principles of data minimization;

- how to ensure contextual consistency across multiple sequential agent calls within a single HR case (for example, hiring a particular candidate).

Contemporary approaches propose using multi-agent systems as mechanisms for auto-validation (agent-as-judge), enabling collective evaluation of outputs generated by other agents, the formation of multidimensional rubrics, and the reduction of individual agent biases. Such frameworks can be adapted for continuous monitoring of decision quality and fairness in HR scenarios, for instance, through periodic "reviews" of system decisions by a group of agents with diverse ethical and functional profiles.

Thus, the theoretical foundations of multi-agent systems and their orchestration form a conceptual framework for developing next-generation HR solutions in IT companies. They integrate classical models of distributed AI (agents, environment, interaction protocols) with contemporary capabilities of large language models, vector knowledge bases, and advanced orchestration patterns. In the following sections, these theoretical principles will be elaborated in the form of architectural solutions, examples of multi-agent HR systems, and an analysis of their advantages and risks within real IT organizations.

For IT companies, where HR processes are closely intertwined with business processes of product development and maintenance, the multi-agent approach appears to be the most natural solution: different agents are responsible for working with different data types, communication channels, and stages of the HR pipeline, while orchestration ensures their coordinated interaction.

Importantly, the multi-agent approach in recruitment is not limited to automating the front office (candidate-facing interactions), but is deeply integrated with internal HRIS, project management systems, and billing systems.

From the perspective of orchestration, modern systems most commonly implement a hierarchical pattern: above the set of operational agents (sourcing, screening, interviewing) operates a manager-agent who (1) receives the business objective (for example, to fill N positions of a particular type), (2) decomposes it into a set of tasks, (3) distributes these tasks among the agents, (4) monitors key metrics (time-to-hire, cost-per-hire, quality of hire), and (5) adjusts the strategy in cases of deviation from the target values.

A second major direction in the use of AI-driven multi-agent systems is the automation of operational HR processes after the hiring stage, including onboarding, employee support, HR administration, interaction with IT services, learning, and professional development.

In the proposed orchestration model of the multi-agent system, AI agents can assume the core procedures of initiating the work of a new employee: automated document verification, pre-filling of forms, initiation of IT service requests (system access, equipment configuration), creation of user profiles, and the generation of personalized training programs that take into account the employee's role, level, and previous experience (Fig. 1).
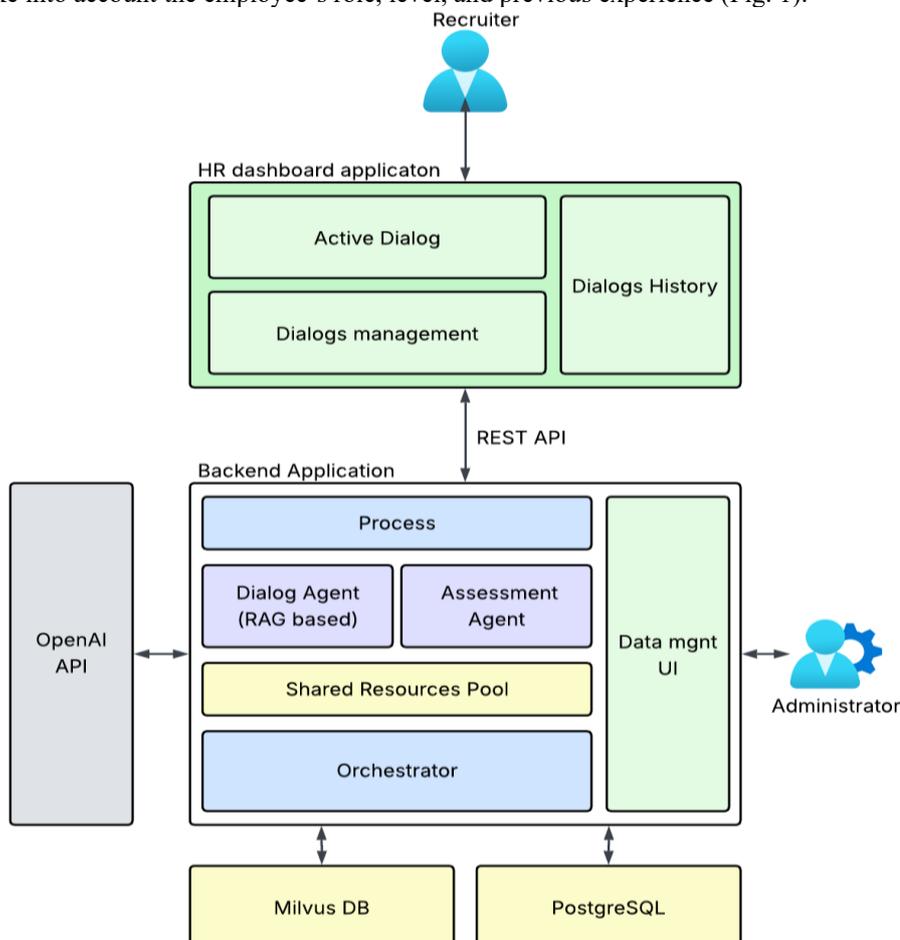

Fig. 1. Architecture of multi-agent orchestration for an application supporting the automation of HRM processes.

In such an architecture, the onboarding process becomes a coordinated interaction among several agents:
- the onboarding agent: guides the employee through the task checklist, responds to inquiries, and provides deadline reminders;
- the document agent: uploads, verifies, and routes the required contracts and forms to the appropriate departments;
- the IT-request agent: integrates with the service desk and automatically creates and tracks support tickets;
- the learning agent: selects courses and materials and adapts the learning trajectory depending on the employee's progress.

There is a problem of trust and perception: both candidates and employees may view "automated HR" with skepticism, particularly when significant decisions are involved. To mitigate this risk, explainability, the possibility of appealing decisions, and a clear communication channel with a human HR professional are essential.

IT companies typically maintain a fragmented digital landscape: separate services for recruitment, learning, performance monitoring, finance, and project management.

The introduction of agents requires a re-evaluation of the entire HR cycle:
- the HR funnel becomes not linear but dynamic and flexible: agents can redirect candidates between roles, propose alternative vacancies, and identify mismatches earlier;
- performance evaluation transforms into a continuous process, where agents regularly monitor risk signals and provide recommendations;
- learning and development become highly personalized, as the agent constructs an individual trajectory adapted to the employee's behavioral and professional data;
- communications become event-contextual rather than calendar-based (for example, an agent independently reminds a manager or employee to review goals).

Such changes necessitate new models of interaction between HR, managers, and employees.

Unlike static HR systems, multi-agent architectures are dynamic: agents are updated, learn, and acquire new roles. MAS transforms HR from a service function into an intelligent strategic center that enables IT companies to effectively automate HR processes.

The orchestration model of the multi-agent artificial intelligence system developed by the authors is based on orchestration principles that ensure the coordination of autonomous agents through a central orchestrator - a meta-agent that performs functions of planning, prioritization, data routing, and result validation. The orchestrator relies on mechanisms of contextual memory, business-process policies, and formal rules that define permissible system states and the relationships among agents.

At the first stage, the recruitment stage, sourcing agents are engaged to automatically generate candidate lists from external platforms, as well as a screening agent that applies NLP models to analyze résumés and assess their correspondence to job requirements. The orchestrator coordinates data verification procedures, prevents profile duplication, and ensures the prioritization of candidates based on relevance.

At the second stage, the candidate evaluation stage, technical testing agents, behavioral analysis agents, and performance-prediction agents based on machine-learning models interact. The orchestrator integrates evaluation results, generates consolidated candidate profiles, and initiates additional procedures in cases of conflicting outcomes.

During onboarding, the system transitions to coordinating documentation, adaptation, and training agents. The orchestrator supervises the implementation of individualized onboarding plans, automatically tracks the employee's progress, and generates recommendations for managers.

At the final stage of the HR life cycle, performance management and development, agents responsible for metrics collection, efficiency analysis, and personalized learning model construction operate. The orchestrator ensures data continuity across stages and generates comprehensive HR analytics reports that make it possible to forecast turnover risks, identify learning needs, and optimize human resource decisions.

Conclusions of the study and prospects for further research in this area

The study demonstrates that the implementation of multi-agent HR systems in IT companies represents a complex technological process, since, unlike traditional HR tools, multi-agent systems not only replace certain operations but also transform the logic of the HR function, restructure the roles of involved actors, and alter the very architecture of human resource management. As a result of the research, a systematic perspective is proposed on how AI-driven multi-agent systems can transform the HR function in IT companies, ensuring its efficiency, scalability, and alignment with the contemporary demands of the digital society.

The findings indicate that the implementation of the proposed orchestration model significantly enhances the coherence and transparency of HR processes. Due to well-coordinated interactions among agents, the system reduces the time required for information processing, improves the quality of candidate and employee assessment, and strengthens the responsiveness of managerial decision-making. At the same time, the orchestration-based approach facilitates the scalability and adaptability of the HR ecosystem, enabling rapid integration of new types of agents or modification of business logic in accordance with the specific needs of an IT company.

Future research will focus on conducting practical experiments to evaluate the impact of orchestration on the speed of hiring software developers in IT companies, the effectiveness of candidate selection, the engagement of IT professionals, and the overall performance of the HR function.

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