IBIMA Publishing
Communications of International Proceedings
https://ibimapublishing.com/p-articles/46ISM/2025/4636025/
Vol. 2025 (29), Article ID 4636025

Artificial Intelligence as a Determinant of Professional Transformation of Real Estate Sector Workers in the Czech Republic in the Early Era of Industry 5.0

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* Presented at the 46th IBIMA International Conference, 26-27 November 2025, Ronda, Spain

Abstract

This study examines the transformation of the professional competencies of real estate sector workers in the Czech Republic in the context of digitalization, the implementation of artificial intelligence, and the emergence of the Industry 5.0 concept, which emphasizes a human-centred approach, sustainability, and cooperation between humans and technology. The aim is to analyse how these processes influence the nature of lifelong professional learning and the development of new metacompetencies in a digitally transformed environment. The research employs a mixed-methods design combining a quantitative questionnaire survey (n = 79) and a qualitative analysis of eight semi-structured interviews. The quantitative data indicated that the greatest use of AI was in text automation, work with visual materials, and document digitalization. The qualitative part identified three competence trajectories: digital adaptability, ethical and decision-making competencies in the context of AI, and complex interdisciplinary learning. The findings confirm a shift from technical skills toward metacompetencies encompassing reflective learning, ethical responsibility, and the ability to collaborate across disciplines. The study emphasizes the need for the concept of Continuing Education 5.0, which develops digital intelligence, ethical culture, and networked collaboration as key elements of sustainability in the real estate sector.

Keywords: artificial intelligence, Industry 5.0, lifelong learning, professional competence transformation, real estate services

Introduction

Since the introduction of the Industry 4.0 concept in 2011, the digital transformation associated with it has attracted attention from both industrial enterprises and governments around the world (Ghobakhloo, 2020). Industry 4.0 builds on the ongoing shift toward a knowledge-based society and is reinforced by the digitalization and cybernization of production, services, and public administration – changes that fundamentally affect the required qualifications and the labour market, including their social impacts (Trading Economics, 2024). Gradually, they bring transformations in work organization, employee roles, and the structure and content of professions, leading to the emergence of new skills and implications for employment. As a result, it will be necessary to redefine the labour market, education, and social policies (Digitální Česko, 2025).

This approach is often described as the "human out of the loop" model, since the main decision-making and control processes occur autonomously through interconnected systems, algorithms, and artificial intelligence, while the human role is largely limited to supervision, maintenance, and parameter setting. Over time, however, it has become clear that such a model encounters limitation when faced with real global challenges. Climate change, the COVID-19 pandemic, and geopolitical crises have revealed the vulnerability of highly automated systems and demonstrated the need for greater adaptability, flexibility, and human involvement in production processes (cf. Goswami, 2021; Willett, 2022; Golovianko et al., 2023). These developments have led to a re-evaluation of industrial strategies and drawn attention to the importance of including a social dimension in

Cite this Article as: Jaroslav VETESKA and Jaroslav KRIZ, Vol. 2025 (29) "Artificial Intelligence as a Determinant of Professional Transformation of Real Estate Sector Workers in the Czech Republic in the Early Era of Industry 5.0" Communications of International Proceedings, Vol. 2025 (29), Article ID 4636025, https://doi.org/10.5171/2025.4636025

technological progress, represented by human capital, cooperation, and resilience. It has become evident that reliance on technological autonomy alone is insufficient, and the new industrial strategy therefore seeks to position humans back at the centre of management and decision-making, not as passive operators but as active co-creators of innovation, value, and strategy. This approach, known as the "human in the loop", means that people remain an essential part of decision-making processes and work with technologies that enhance their abilities rather than replace them. This shift in perspective gave rise to the concept of Industry 5.0, which emphasizes human creativity, cooperation, social responsibility, resilience, and sustainability as central elements of industrial transformation (cf. Golovianko et al., 2023).

Unlike its predecessor, Industry 5.0 does not focus solely on technological advancement but seeks a holistic approach that connects technological efficiency with environmental and social responsibility. Technology is not an end in itself but a tool for strengthening human capabilities and improving the quality of life. In this new stage of industrial development, the importance of skills related to artificial intelligence, the circular economy, ethical technology use, and corporate social responsibility continues to grow. Corporate education has thus become a key instrument for workforce development, as it must respond not only to digitalization but also to the environmental and social demands associated with the new phase of industrial transformation. The success of both companies and employees increasingly depends on their ability to combine technical expertise with soft skills, sustainability, and lifelong learning (Friedman, 2023).

This study focuses on the real estate services sector, which in recent years has undergone significant digital transformation through technologies collectively referred to as "PropTech", a term that is now established in both academic and professional discourse and is understood as part of the wider digital transformation of the real estate industry and represents a shift towards technology-driven innovation in data, transactions, and the design of buildings and cities (Tagliaro et al., 2025).

In the real estate sector, data have a central role in business processes, and artificial intelligence (AI) now plays a crucial part in transforming operations and decision-making, with a variety of tools developed by both start-ups and established PropTech companies enabling the automation of routine tasks, more efficient data management, and personalized services (Gardes, 2025). This technological transformation, and the transition from Industry 4.0 to 5.0, places new demands on employees' skills and creates the need for lifelong professional learning, and the aim of this study is to examine how digitalization, artificial intelligence, and the principles of Industry 5.0 are reshaping professional competencies and lifelong learning among real estate professionals in the Czech Republic. The study identifies key trends in adapting to technological innovation, and in the ethical and cooperative dimensions of professional practice, and formulates the foundations for the concept of Education 5.0, which connects technological progress with the development of human capital and social sustainability.

Analysis of Labour Market Changes in the Context of Digitalization and the Real Estate Services Sector in the Czech Republic

Employment in the Czech Republic has long remained at a very high level compared with other European countries and continues to show stable growth. In the second quarter of 2025, the employment rate among people aged 15–64 reached 75.7%, representing a year-on-year increase of 0.4 percentage points (Czech Statistical Office, 2025). The total number of employed people stood at 5,243,500, which is 76,200 more than in the same period of the previous year. Employment in the tertiary sector increased by 88,000 year on year, with the fastest growth recorded in the fields of cultural, entertainment, and recreational activities (+24.3%), information and communication activities (+9.1%), and other services (+11.3%).

From the perspective of analysing the real estate services sector in the Czech Republic, real estate activities form an important and structurally specific part of the national economy. The sector accounts for roughly 12% of gross value added, and after adjusting for imputed rent, its share represents around 3% of both gross value added and total employment (Czech Statistical Office, 2025). In recent years, the Czech real estate market has been in an expansionary phase, as evidenced by the strong growth of residential property prices. In the first quarter of 2025, the housing price index rose by 10% year on year, with prices of new dwellings increasing by 13% and those of older ones by 9.3% (Grossmann et al., 2025). The pace of price growth in the Czech Republic ranks among the fastest third within the European Union, and the continuing rise in prices outpaces the overall economic cycle, which may indicate that the economy is transitioning into a phase of expansion.

A synthesis of labour market changes and the development of the real estate services sector shows that these two areas can no longer be viewed in isolation. Digital transformation, the emergence of the Industry 5.0 concept, and

the growth of PropTech technologies are creating new forms of interdependence and cooperation between the ICT sector and real estate services.

Continuing Education 5.0 in the Real Estate Sector

Continuing Education 5.0 in the real estate sector represents a key instrument for adapting the workforce to the structural changes brought about by Industry 5.0, digitalization, and the development of PropTech technologies. These changes are fundamentally transforming the nature of professional activities, organizational models, and skill requirements, leading to the emergence of new forms of interconnection between the ICT and real estate sectors. The synthesis of these areas shows that continuing education can no longer be viewed merely as a means of updating professional knowledge but rather as a strategic process for developing complex competencies that are essential for sustainable growth, innovation, and market resilience. A central role is played not only by digital and technical skills but also by the ability to engage in interdisciplinary collaboration, apply systems thinking, use technology ethically, and work effectively with data (Veteška, 2016).

It follows that today's real estate market requires professionals to engage in continuous development of their expertise, and one of the key drivers of these changes is the steady increase in the volume of data that must be processed efficiently to be fully utilized. This trend has led to the growth of advanced technologies for working with large data sets, such as machine learning and artificial intelligence (Ellili et al., 2023), with companies therefore needing to develop employee skills systematically in the areas of automation, digitalization, data literacy, and innovation. Instead of one-off training sessions, greater emphasis will increasingly be placed on ongoing professional development, internal mentoring, retraining programmes, and collaboration with universities and educational and research institutions (Rikala et al., 2024).

At the core of the Continuing Education 5.0 concept lies sustainability, understood not only as an environmental but also as a social and economic principle. A systematic literature review by Al-haimi et al. (2025) focusing on the digital transformation of the real estate sector identified 36 relevant studies confirming that the implementation of technologies such as artificial intelligence, the Internet of Things, blockchain, and augmented and virtual reality significantly increases operational efficiency, improves data-driven decision-making, and deepens user engagement.

In terms of implementing artificial intelligence in the real estate sector, a substantial body of research already exists describing structural changes across the entire value chain – from predictive market analytics and asset valuation to the automation of transactional and back-office processes, as well as the personalization of client interactions (Huang & Rust, 2018; Ameen et al., 2021). However, these benefits are accompanied by the augmentation–automation paradox (Raisch & Krakowski, 2021): AI tools both extend human capabilities and standardize decision-making and can therefore be perceived as a potential threat to the professional autonomy of real estate practitioners (Gardes, 2025).

Workers in the real estate sector represent a vital part of the market infrastructure, as they facilitate capital, property, and insurance transactions, influence client decision-making, and contribute to the transparent and efficient functioning of the market. Lifelong professional learning is therefore not an optional supplement but a systemic precondition for sustainability, competitiveness, and ethical professional practice in the context of digital transformation and Industry 5.0.

Research Methods

This research focused on analysing the use of artificial intelligence in the real estate services sector in the Czech Republic and was designed as a mixed-methods study combining quantitative and qualitative methodological approaches. The chosen mixed-methods design reflects the need to capture the complex nature of the phenomenon, which encompasses technological, organizational, and human dimensions of the transformation of the real estate sector in the context of the emergence of Industry 5.0. The quantitative component made it possible to examine the extent and forms of artificial intelligence use across the sector and to identify trends and patterns in its implementation. The qualitative component then provided deeper insight into the context of AI use and into the changing competence requirements placed on professionals in this field. Combining the two methodological approaches strengthened the validity of the findings and enabled the formulation of more comprehensive conclusions and implications for future practice.

The quantitative phase of the research was conducted through an online questionnaire survey, in which a total of 116 entities, selected by random sampling, were contacted and 79 responses were received from organizations operating as real estate agencies, brokerage firms, or property management companies. The aim of this phase was

to assess the level of application of artificial intelligence and related digital technologies in real-world practice and to identify their benefits and limitations. This was followed by a qualitative phase, in which selected participants were invited to take part in semi-structured interviews, which enabled a more detailed analysis of the factors influencing the implementation of artificial intelligence, including perceptions of its organizational impacts, barriers to adoption, and the specific competence needs of workers in the real estate services sector.

The results of the qualitative analysis contribute to a systematic overview of the key competencies necessary for effective application of artificial intelligence and provide a basis for developing continuing education strategies that can enhance the competitiveness of the real estate sector in the context of the digital economy and the rise of Industry 5.0.

Research Results

The results of the survey, summarized in Table 1, show that the use of artificial intelligence in the real estate services sector in the Czech Republic extends across a wide range of areas. These reflect the structural transformation of the entire industry and fundamentally redefine the professional competence requirements of its workforce.

Table 1: Areas of Artificial Intelligence Application in the Real Estate Services Sector in the Czech Republic

Area of Education and Development	Frequency of Artificial Intelligence Use	%
Digitalization of Legal and Contractual Documents	49	62%
Use of AI in Text Processing (Automated Analysis and Content Generation)	60	76%
Use of AI in Working with Visual Materials (Photographs, Videos, Virtual Tours)	70	71%
Use of AI in Data Processing (Scoring, Predictive Analytics, Calculators, Market Monitoring)	40	51%
Use of AI in Marketing and Social Media Management (Targeting, Offer Personalization)	42	53%
Digital Security, Data Protection, and Cyber Resilience	49	62%
AI Agents and Process Automation (Chatbots, Automated Workflows)	51	65%

Source: Authors' elaboration

The highest level of AI implementation was recorded in the area of automated text processing and content generation (76%), which reflects the need to process large volumes of information efficiently, accelerate administrative procedures, and increase the accuracy and consistency of documentation. A similarly high proportion of respondents reported using AI for working with visual materials (71%), including automated photo editing, visualization generation, and the creation of virtual tours, which illustrates the growing importance of visual property presentation in a competitive market environment.

Attention is also directed towards process automation through AI agents (65%) and the digitalization of legal and contractual documents (62%), pointing to an increasing need to streamline routine tasks, minimize errors, and ensure greater legal certainty in business transactions. Areas related to predictive data analysis (51%) and targeted marketing (53%) confirm a shift towards data-driven decision-making and service personalization. Respondents also attached significant importance to digital security, data protection, and cyber resilience (62%), which constitute essential prerequisites for the trustworthiness and sustainability of digital innovations in the real estate market environment.

Based on the online survey, further attention was devoted to planned projects involving the implementation of artificial intelligence in real estate sector processes. The results show that the most frequently planned innovations

include chatbots integrated into company websites (85%), digitalization of contractual documents (76%), and digital client onboarding (74%). These areas reflect the growing emphasis on automating customer communication, streamlining administrative processes, and improving user experience (see Figure 1).

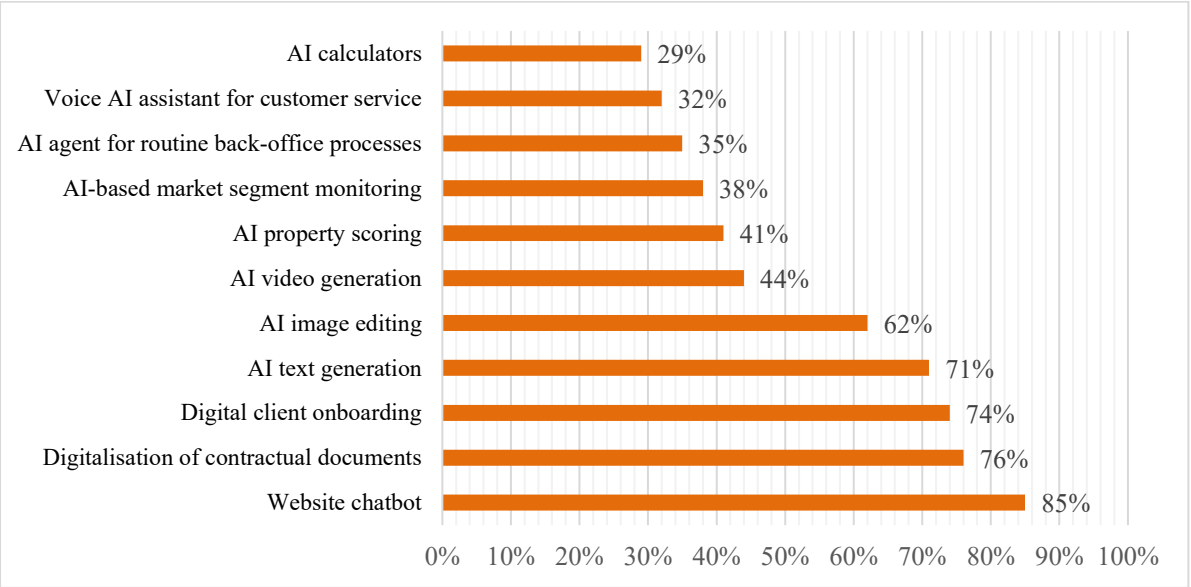

Figure 1: Most Frequently Planned AI-Driven Innovations in the Real Estate Services Sector in the Czech Republic

Source: Authors' elaboration

Additional representation was found in projects related to text generation (71%) and visual content creation (62%), indicating a shift toward data-driven content and personalized marketing strategies, and confirming the trend that digital transformation permeates all key areas of real estate business, from front-office interactions to back-office automation. However, the data analysis also reveals that current projects focus primarily on technical and operational dimensions, while less attention is given to strategic priorities associated with the emergence of Industry 5.0. For this reason, a qualitative part of the research was also conducted, which, through semi-structured interviews with eight industry experts, enabled a deeper understanding of the organizational and human aspects of implementing artificial intelligence. These findings complement the quantitative data by providing an interpretation of broader contextual meanings and offer a more comprehensive insight into the challenges that digitalization brings to this segment.

Based on semi-structured interviews with eight professionals from the real estate sector, a qualitative analysis was carried out to examine the effects of digitalization, automation, and the use of AI tools on employees' competences. The interviews were analysed using open coding (Strauss & Corbin, 1998), with individual codes subsequently grouped into thematic categories reflecting new forms of professional learning and the changing nature of work roles in the context of Industry 5.0 and the development of PropTech technologies. The analysis identified three main categories regarding the impact of technological change on professional competences, as depicted in Table 2:

Table 2: Results of Qualitative Analysis of the Impact of Digitalization and Artificial Intelligence on the Professional Competences of Real Estate Sector Employees

Category	Examples of Codes Identified in the Data

Digital Adaptability and Skills Transfer	adapting to new systems and applications; learning through trial and error; searching for information and online tutorials; self-directed learning; sharing experiences with colleagues; microlearning; knowledge transfer across different technologies (CRM, AI tools, visualizations); interest in continuous learning; improved work efficiency through digital tools; learning by doing
Ethical and Decision-Making Competences in the Context of AI	responsibility for AI-assisted decision-making; property valuation and sales; verification of predictive model outputs; critical evaluation of algorithmic recommendations; balancing human judgment; ethical handling of client data; concerns about loss of autonomy; reflection on the effects of automation on clients
Complex Learning and Interdisciplinary Collaboration	collaboration among real estate agents, IT specialists, lawyers, and marketing professionals; sharing knowledge about digital trends (AI, PropTech); participation in teams implementing new technologies; combining technical and soft skills; emergence of new professional roles such as digital coordinator and data analyst

Source: Authors' elaboration

The first category, digital adaptability and skills transfer, represents a key factor in the professional flexibility of employees in the real estate sector amid rapidly evolving technologies. The interview analysis showed that real estate agents and property management specialists must constantly adapt to new digital systems – from CRM platforms and automated marketing tools to visualization systems and applications using artificial intelligence for market price estimation or predictive demand analysis. Digital adaptability thus becomes not only a technical competence but also a cognitive and attitudinal one, shaping the ability to respond innovatively to technological change, to use digital resources effectively, and to maintain professional competitiveness in the era of Industry 5.0.

The second category, ethical and decision-making competences in the context of AI, reflects the need to redefine the boundary between human decision-making and automated processes. Respondents emphasized responsibility for the outcomes of AI-supported decisions and the importance of critically verifying both data accuracy and algorithmic outputs. Their accounts revealed an awareness that technological tools can optimize performance but cannot replace human ethical judgment. Within the real estate sector, concerns about the loss of professional autonomy emerge particularly in situations where AI-driven systems recommend specific procedures, pricing strategies, or types of client communication. These tools, often implemented in the form of CRM systems, scoring models, or predictive algorithms, work with extensive data sets and generate suggestions intended to support agents' decision-making. Several respondents noted that, although the system offers rational, data-based options, these do not always correspond to the context of a specific client or locality, which creates an ethical and professional dilemma over whether to rely on the algorithm or on personal experience and intuition. The category thus confirms that ethical competence is becoming an integral part of professional expertise in the digital age.

The third category, complex learning and interdisciplinary collaboration, reflects a deeper transformation in the nature of professional development that extends beyond individual education. Respondents observed that effective performance in a digitalized work environment requires the ability to collaborate across professional domains, such as IT, law, marketing, and data analytics. In real estate practice, this interdisciplinarity takes a concrete form in processes that link technological infrastructure with the legal and commercial aspects of transactions. Agents, for example, must consult with IT specialists when implementing new CRM systems, visualization tools, or automated client communication platforms. Legal experts have become indispensable in evaluating electronic contracts, ensuring compliance with data protection legislation (GDPR), and implementing digital signatures.

Learning here takes place as a dynamic interaction based on experience sharing, team reflection, and collaborative problem solving. Alongside technical competences, the development of so-called "soft skills", particularly communication, coordination, and empathy, is also strengthened, as these enable the effective transfer of knowledge across different professional domains.

Discussion

The findings of the research confirm that the implementation of artificial intelligence (AI) tools in the real estate sector represents a fundamental transformation of professional structures, work roles, and educational needs. The quantitative part of the survey showed that in the Czech Republic the most significant effects are evident in areas related to document digitalization, administrative process automation, and AI-assisted content creation. These findings reflect a shift from the traditional model of real estate services, based on personal expertise and experience, toward a model that is data driven, technologically supported, and process automated. At the same time, the qualitative findings reveal that this technological transformation also brings new challenges related to professional identity, ethical responsibility, and the need to develop new forms of learning.
The interview analysis revealed that one of the key adaptation mechanisms among real estate professionals is digital adaptability and skills transfer – that is, the ability to learn continuously, master new digital systems, and transfer experience effectively across different technological environments. The results also indicate that a new type of professional is emerging within the real estate sector: a technologically competent individual who integrates digital literacy with business and social skills.

The research showed that real estate agents are increasingly engaging in interdisciplinary collaboration with IT specialists, lawyers, and data analysts, which is fundamentally transforming the nature of their professional learning. The educational process is shifting from individual knowledge acquisition to team-based reflection and cross-professional knowledge sharing – a development that is leading to the emergence of a hybrid professional identity that integrates technical, legal, and communication competences and enables the effective implementation of artificial intelligence in accordance with the principles of Industry 5.0.

Based on the qualitative analysis, three key areas were identified that reflect the changing nature of professional competences in the real estate sector in connection with digitalization and the implementation of AI tools. These areas not only represent the current state of professional learning and worker adaptation but also indicate the future direction of competence development in the context of Industry 5.0. Table 3 summarizes the research findings by category, theoretical implications, and recommendations for professional practice and education.

Table 3: Synthesis of Findings and Forecast of Professional Competence Development among Real Estate Sector Employees in Industry 5.0

Category	Current State (Research Findings)	Competence Development Forecast / Theoretical Implications	Recommendations for Practice and Education
Digital Adaptability and Skills Transfer	In practice, adaptive and predominantly informal learning prevails, based on trial and error, independent information seeking, and experience sharing. Digital literacy serves as a key prerequisite for professional flexibility.	A shift is expected from digital literacy to digital intelligence, understood as the ability to reflect on one's own learning within a technologically dynamic environment. The concept of meta-adaptive competence is emerging, encompassing the capacity to critically understand data structures and their use in decision-making processes (cf. Friedman, 2023; Rikala et al., 2024; Carminati et al., 2025).	Implement systematic educational models that support adaptive and reflective learning. Develop modular curricula focused on fostering digital intelligence, metacognitive strategies, and adaptation to new technologies. The findings also suggest the inclusion of mentoring and peer learning as effective approaches.
Ethical and Decision-Making Competences in the Context of AI	Respondents reflected on the tension between human judgment and algorithmic recommendation. Concerns emerged regarding the loss of professional autonomy and responsibility for outputs generated by AI.	A new ethical framework of professional practice is taking shape. There is a growing need for algorithmic accountability, meaning the ability not only to use AI but also to understand its decision-making logics, interpret algorithmic outputs, and assume responsibility for their application (cf. Granata et al., 2024; Carminati et al., 2025; Gardes, 2025).	Integrate AI ethics, critical thinking, and algorithmic process analysis into professional education. Based on the research findings, it is recommended to develop professional ethical codes and educational modules aimed at fostering ethical reflection in working with data and algorithms.
Complex Learning and Interdisciplinary Collaboration	Real estate professionals are increasingly collaborating with IT specialists, lawyers, and data analysts. Hybrid professional identities and coordination roles are emerging as a result.	The direction of development points to the emergence of interdisciplinary teams in which the boundaries between professions are becoming blurred, and a key competence is the ability to translate between technological, legal, and commercial discourses (cf. Gamberini & Pluchino, 2024; Granata et al., 2024; Carminati et al., 2025).	Support the development of interdisciplinary educational modules that combine the technical, legal, and social aspects of professional practice. Introduce project-based learning formats and networked learning. Strengthen employees' communication and coordination skills.

Source: Authors' elaboration

The table shows that the transformation of professional competences in the real estate sector extends beyond technical knowledge and emphasizes the development of metacognitive, ethical, and collaborative skills. The key metacompetence in the era of Industry 5.0 is adaptive capacity, which enables professionals to navigate technologically driven environments through strategic flexibility, digital literacy, and human-centred abilities. Research (Mourtzis, 2023; Ikenga & van der Sijde, 2024) indicates that these competences integrate technical proficiency with critical thinking, sustainability, and autonomous learning. Metacompetence thus provides a central framework for professional adaptability and workforce development in the context of transformation toward a human-centric industry.

The data presented in Table 3 demonstrate that digitalization and the implementation of artificial intelligence tools are transforming the nature of professional learning – from individual skill acquisition toward team-based, reflective, and interdisciplinary collaboration. These tendencies correspond to the principles of Industry 5.0, which link technological progress with human creativity, responsibility, and cooperation. The identified competences therefore form the basis for the development of the concept of Education 5.0, which reflects the need for long-term cultivation of adaptive, ethically grounded, and systemically minded professionals capable of functioning within a digitalized services environment.

Overall, the results suggest that the successful integration of artificial intelligence into real estate practice depends not only on technical expertise but also on the ability of professionals to adapt to new processes and to use AI as a tool for improving efficiency, service quality, and the long-term competitiveness of the sector in the context of Industry 5.0. From a forward-looking perspective, it is expected that in the coming years, in line with Golovianko et al. (2023), the concepts of Industry 4.0 and 5.0 will coexist and, in some cases, integrate into hybrid models that combine automation and artificial intelligence with human creativity and values. This hybrid approach may represent the most effective path toward the emergence of a new generation of intelligent, sustainable, and resilient industrial systems capable of responding more effectively to the complex challenges of the contemporary world.

Conclusion

In terms of the limitations of this study, it is important to view them in the context of its focus on the early phase of artificial intelligence and digital technology implementation within the Czech real estate sector. The findings primarily reflect adaptation processes among employees and organizations rather than their long-term effects on professional identity, educational strategies, or market dynamics. The sample size and its regional focus do not allow for generalization to the entire sector; nevertheless, the results offer a valuable insight into current trends in digitalization and competence transformation. Based on these limitations, future research should be expanded to include a comparative analysis across different segments of the real estate market (e.g. residential, commercial, and development sectors) and international comparisons that would make it possible to assess the specific characteristics of the Czech context within a broader European framework. A longitudinal approach would also seem promising, as it would trace the evolution of professional competences over several years and capture the effects of educational interventions on adaptability and the ethical dimension of decision-making.

Upskilling and reskilling of the workforce are crucial for the successful realization of Industry 5.0. Technical skills are essential in order to maximize investments in smart systems, while industry leaders increasingly require more AI-related talent to drive the emerging AI-powered industrial revolution (Mourtzis et al., 2022).

Acknowledgements

This text was developed as part of the Cooperatio Programme (Charles University, Faculty of Education, 2022–2026), under the research area of Education and Pedagogy (GEED).

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