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Innovative strategies for the development of personnel management on the example of the construction sector

Abstract. The growing complexity of construction projects combined with the digital transformation of the industry makes it necessary to modernise personnel management systems, which is a key factor in ensuring the competitiveness of construction enterprises. The purpose of the study was to develop a comprehensive digital human resources (HR) management system designed to increase the efficiency of HR processes in the context of dynamic technological changes. The methodological foundation of the paper was based on the analysis of corporate documentation of 8 international construction companies for the period 2020-2023, which served as a basis for evaluating and implementing innovative HR strategies. Among the critical achievements, the integration of artificial intelligence into recruitment processes is notable, which reduced the recruitment time by 32% and substantially improved the quality of candidate selection (an increase of 45%). The use of virtual reality (VR) simulations in training programmes reduced the error rate when performing complex production operations by 45%. In addition, the developed competence monitoring system, based on 15 parameters of construction processes, contributes to the formation of reference profiles of specialists. The transformation of the workspace based on the activity-based working principle had a positive impact on the level of professional burnout, reducing this indicator by 18%, and increasing labour productivity by 16%. The implemented well-being support programmes recorded a 22% reduction in the number of sick days, and the development of cross-functional teams accelerated the introduction of innovations by 35%. The combination of these results creates a practical basis for the modernisation of HR processes in the construction industry. The study materials can be used to develop professional development programmes, adapt innovative HR management methods, and form digital transformation strategies in the context of the specifics of the construction industry

Keywords: digital transformation; professional competencies; cross-functional teams; predictive analytics; well-being programmes

INTRODUCTION

The modern construction industry is at the stage of substantial transformation due to the active introduction of digital technologies, automation

of work processes, and innovative approaches to labour organisation. The complexity of construction projects, increased competition and

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growing quality requirements create new management challenges, especially in the field of human resource management. This determines the relevance of developing and implementing innovative human resources (HR) management strategies aimed at attracting, professional development, and long-term retention of highly qualified specialists.

According to the study by M. Omelianenko & Y. Krychevska (2024), Ukraine is experiencing substantial changes in the management systems of construction enterprises. In particular, more than 35% of Ukrainian companies in the construction sector have integrated automated project management systems, such as enterprise resource planning (ERP) solutions and resource management systems. Thereby, in the UK and Germany, more than 40% of such companies use artificial intelligence-based analytics technologies to optimise management processes. However, a publication of P. Budhwar *et al.* (2023), offers a fundamentally new perspective on the impact of generative artificial intelligence on HR processes. As part of a large-scale analysis covering a sample of 8,370 employees in 10 countries, the authors showed interesting results: 50% of employees surveyed actively use artificial intelligence (AI) technologies in their work, while 64% stated a higher degree of trust in AI solutions compared to traditional management approaches. In this context, the model of integration of artificial intelligence into HR systems proposed in the study was important, including the development of digital competencies and the use of predictive approaches to talent management.

A revolutionary approach to the introduction of artificial intelligence was highlighted in the paper of S. Chowdhury *et al.* (2023). Developed by the authors, the AI capability framework, based on interdisciplinary analysis, identifies five key organisational resources that are crucial for successful transformation based on artificial intelligence. Attention should be paid to a set of practical tools for self-assessment of organisations' readiness for change and recommendations for gradually acquiring the necessary competencies. The fundamental changes caused by the impact of the concept of Industry 4.0 on the field of human resource

management are justified in the study by L.B.P. da Silva *et al.* (2022). Based on the analysis of 93 scientific papers, the authors identified 13 fundamental areas of change – from the introduction of the principle of digital culture to the creation of adaptive learning systems of a new generation. The main conclusion is the need to develop multidisciplinary competencies and implement comprehensive digital literacy programmes.

The importance of HR management in times of crisis was emphasised by S. Hamouche (2023). Analysing the practices of 150 companies during the COVID-19 pandemic, the author presented an innovative model of personnel management in crisis situations. The proposed solutions cover the introduction of flexible forms of employment, the active development of digital skills of employees, and the formation of psychological support systems to ensure the resilience of employees to stressful factors. K. Wasilkiewicz Edwin *et al.* (2024) concentrate on the critical link between project management and occupational health in the Norwegian construction industry. By applying benchmarking tools and analysing incident statistics, the authors created an innovative model for integrating security into all stages of construction projects – from planning to financial resource management.

Management problems in the construction sector are reviewed from a new perspective by V. Kulba *et al.* (2016). Using scenario modelling, the researchers identified systemic problems in the industry, including inefficient government regulation and income inequality. The proposed mechanisms for increasing transparency in management and financial processes are designed to become the basis for the transformation of the industry. J.F. Molina-Azorin *et al.* (2021) presented a new approach to environmental management in the context of human resources management. The authors summarised the relationship between environmental management approaches and HR strategies, highlighting that companies with efficient ecosystems demonstrate higher team productivity. Special attention was paid to the role of “green teams” in the implementation of environmental initiatives. The aspect of transforming HR processes through the use of project management was considered in a study by C.E. Oehlhorn *et al.* (2020).

After analysing 71 articles, the authors identified the defining role of HR departments in achieving strategic harmony between business and IT processes. The study highlighted the need for HR to move from an administrative to a strategic function in the context of digital transformation.

An inclusive approach to talent development was stressed by M. Kaliannan *et al.* (2023). Based on a systematic review of the literature from 1997 to 2020, the authors demonstrated the advantages of inclusive talent development methods over traditional elite approaches. The results showed that external hiring costs are 18-20% higher than internal recruitment costs. Revolutionary approaches to security management are determined by C. Okonkwo *et al.* (2023). Based on a survey of 52 construction project managers with an average experience of more than 18 years, the authors identified the main obstacles to implementing smart safety systems and outlined practical recommendations for overcoming them.

A valuable contribution to the examination of psychological aspects of management was presented in the paper of T.C. Dodanwala & D.S. Santoso (2024). Based on data from 274 project-level employees, the researchers determined a complex dynamic between personality traits and role stress, suggesting modern approaches to stress management in the construction industry. A special place in resource management is occupied by the findings of L. Hasselsteen *et al.* (2024). Combining systematic literature analysis and in-depth interviews with ten industry experts, the authors presented a framework for bridging the gap between scientific knowledge and the practical needs of the construction industry.

The analysis of the study indicates insufficient attention to the specifics of implementing innovative HR management strategies in the construction industry of Ukraine. There are still issues of digital transformation and new requirements for the professional competencies of employees. The aim of this study was to create a comprehensive approach to the development of innovative HR management strategies focused on the construction sector of Ukraine, considering international experience. The following tasks are planned to achieve this goal: evaluate

current trends and key challenges in personnel management in the construction industry; analyse the best practices of applying innovative HR strategies in leading international construction companies; offer recommendations for adapting these practices to the realities of Ukrainian construction companies.

MATERIALS AND METHODS

The empirical foundation of the study was built on the basis of corporate documentation of eight international construction companies for the period from 2020 to 2023. The analysis included data from leading industry representatives such as Vinci Construction (2023), Hochtief (2023), Skanska (2023), Balfour Beatty (2023), and Strabag (2023), each of which has an annual turnover of more than 10 billion euros. In addition, the practices of PORR (2023), Ferrovial (2023), and Bouygues Construction (2023) were assessed. The study was based on materials such as annual company reports, corporate presentations, official press releases, and internal documentation from HR departments.

The technical documentation for implementing artificial intelligence in HR processes described in the paper of P. Budhwar *et al.* (2023) was analysed to examine recruitment systems. The analysis of materials for optimising work processes covered the transformation of office space according to the activity-based working principle in concert with the data of K. Wasilkiewicz Edwin *et al.* (2024), which included an analysis of the practices of leading construction companies in Norway and the results of employee surveys on the effectiveness of new formats for organising workspaces. The developments of L. Hasselsteen *et al.* (2024), which included ten in-depth interviews with industry experts on workflow optimisation, were also utilised. Well-being programmes were also investigated, including Hochtief reports on the implementation of a comprehensive programme to support staff physical and psychological health.

The methodological basis of the study was founded on a comprehensive approach to analysing the transformations of HR processes in the construction industry. Methods of comparative analysis of key indicators before and after digital integration were used to assess the

effectiveness of recruitment procedures. The quality of recruitment was assessed by calculating the success rates of completing the trial period and the degree of compliance of candidates with the established position profile. The analysis of the development of professional competencies was carried out through the evaluation of the effectiveness of training programmes.

The study used quantitative analysis methods, in particular, the analysis of data on participation in certification programmes, the results of testing technical skills, and labour productivity after completion of training. Statistical data was processed using the SPSS Statistics 27.0 software for analysing the dynamics of performance indicators. The examination of personnel retention strategies included an analysis of the structure of compensation packages and motivation systems. Economic analysis methods were used to calculate the profitability of training programmes (ROI) and evaluate the effectiveness of investments in employee development. The effectiveness of well-being programmes was assessed by analysing the level of professional burnout and overall employee satisfaction.

The processes of digital transformation of HR functions were examined through the analysis of documentation on implemented technological solutions. The effectiveness of VR technologies in training programmes was evaluated by comparing training results before and after using virtual simulators. Evaluation of the performance of neural network systems for recruitment was based on an analysis of the accuracy of predicting the success of candidates, followed by validation of results using historical data. The productivity of project teams and the dynamics of implementing innovative solutions were analysed to assess the effectiveness of cross-functional teams. System analysis methods were used to measure the impact of digitalisation on the overall effectiveness of HR processes, and predictive analytics in HR management was reviewed through the consideration of data processing algorithms and applied results. The data triangulation method was used to increase the reliability of the obtained conclusions, which involved comparing information from different sources. The economic efficiency of HR strategies was evaluated using a comprehensive

analysis of financial indicators and development dynamics. The proposed methodology provided a systematic understanding of the processes of transformation of the personnel management system in the construction sector.

RESULTS

Strategies for finding and attracting talent in the construction industry: an analysis of international practices

The practices of five leading international construction companies, such as Vinci Construction, Hochtief, Skanska, Balfour Beatty, and Strabag, for the period 2020-2023 exhibited the active introduction of digital technologies in recruitment processes. Analysis of the use of artificial intelligence in HR processes by Vinci Construction (2023) shows a reduction in recruitment time by 32% and an increase in the quality of candidate selection by 45% due to multi-factor competence analysis. In turn, S. Chowdhury *et al.* (2023) confirmed similar trends, demonstrating how the integration of AI systems has substantially changed the approach to evaluating candidates through in-depth analysis of technical skills, behavioural characteristics, and developmental potential. Analysis of the practice of Vinci Construction demonstrated the results of implementing the SAP SuccessFactors platform for personnel management. The system reduced the time required to process personnel documents from 5 to 2 days along with the cost of managing HR processes. However, there are difficulties with integrating data from old systems and the need for additional training of personnel to work with the new platform. The practice of Hochtief (2023) was distinguished by the introduction of an integrated predictive analytics system for evaluating candidates. Such a system considers a wide range of parameters: technical and managerial skills, experience in international projects, and professional growth prospects. Hochtief introduced the workday HR management platform, which allowed centralising employee recruitment and adaptation processes. As a result of the implementation, staff turnover among technical specialists decreased by 15%. The main implementation challenges included resistance to change among mid-level management and the need for parallel

documentation management in the two systems during the transition period.

The transformation of HR processes in the construction industry took place through the introduction of various types of HR management strategies. The digital transformation of HR included recruitment automation, learning management systems, predictive analytics, and digital document management. Staff development was implemented through technical training, corporate educational platforms, and competence assessment systems. Talent retention strategies were based on employee support programmes and the modernisation of motivation systems. Performance management was carried out through measurable performance indicators and project team development.

Skanska (2023) introduced a digital recruitment process monitoring platform that provides performance monitoring at every stage of interaction with candidates – from the initial screening to the end of the probationary period. The Cornerstone OnDemand training

platform for staff development was implemented. The system provided for the creation of individual development plans and tracking the progress of training. The results included increased employee engagement and an improved team atmosphere through a transparent professional growth system. Among the disadvantages, there are limited opportunities for offline training and technical difficulties when working with large video files. In general, the introduction of digital tools has radically transformed approaches to evaluating the effectiveness of recruitment in the construction industry. Integration of analytical systems allowed tracking key metrics in real time and optimising recruitment processes based on the data obtained. A detailed analysis of fundamental recruitment performance indicators illustrates a comprehensive approach to evaluating the effectiveness of recruitment (Table 1). Monitoring systems covered all stages of working with candidates – from the first contact to the successful completion of the probationary period.

Table 1. Metrics of recruitment performance in the construction industry

Metric category	Indicators	Measurement methods	Optimisation tools
Hiring quality	Successful completion of the probationary period, compliance with the position profile	Manager's assessment, KPIs of new employees	AI-scoring candidates
Closing speed	Time from opening to closing of the vacancy, speed of completion of stages	Automatic tracking, milestone analysis	Process automation, predictive search
Cost of attraction	Costs per employee hired, ROI of recruitment channels	Financial analytics, attribution models	Channel diversification, targeting
Talent retention	Percentage of retention after a year of work, level of engagement	Regular surveys, layoffs analysis	Adaptation programmes, development systems
Quality candidate experience	NPS candidates, process satisfaction	Feedback, automated surveys	Digital interfaces, personalisation of communication

Note: target values vary depending on the category of personnel and the market situation

Source: created by the author

The integration of digital technologies into human resource management processes has become a critical factor in the development of multi-level search systems and in attracting qualified specialists in the construction industry. Automation of the first stages of candidate screening and evaluation has radically changed the functioning of HR departments, allowing

them to focus on in-depth communication with applicants and detailed assessment of professional competencies. Routine tasks were transferred to automated systems, which tripled the number of processed applications without expanding the staff of HR specialists.

At Balfour Beatty (2023), the introduction of digital technologies was based on the use of

integrated machine learning systems to optimise the personnel evaluation process. The developed algorithms analysed an extensive amount of data on successful employees to form reference profiles for the main professional specialisations in the construction sector. In turn, in Strabag (2023), the use of predictive analytics tools contributed to modelling the career development trajectories of employees based on historical data on the professional path in the company. PORR (2023) has integrated a candidate assessment system into its practices, which provides for a comprehensive test of technical knowledge and management and communication skills. Technical evaluation of candidates included performing practical tasks in the design and calculation of building structures, while soft skills analysis focused on identifying the ability to work effectively in cross-functional teams. The company has also implemented the

TalentLMS training platform for technical training of personnel. The system provided access to training materials via mobile devices, which increased employee engagement in training by 40%. Among the challenges, the difficulty of creating high-quality VR content for technical trainings and the high cost of developing simulations of construction processes were noted.

Bouygues Construction (2023), in turn, has developed its own methodology for assessing the adaptability of applicants through modelling complex production situations and then analysing their decisions. Analysis of the effectiveness of implemented technological innovations and modern methods of evaluating candidates indicates high efficiency in solving the personnel needs of the construction industry (Table 2). Each methodology is aimed at identifying specific characteristics of individuals and predicting professional success for specific positions and tasks.

Table 2. Innovative methods for evaluating candidates in the construction industry

Evaluation method	Estimated parameters	Technological solutions	Field of application	Efficiency
Digital simulations	Technical skills, decision-making, stress tolerance	VR/AR platforms, AI analytics	Engineering and technical personnel	High accuracy of technical assessment
Behavioural analysis	Leadership skills, communication, adaptability	ML algorithms, video analytics	Management positions	Forecasting leadership potential
Professional testing	Specialised knowledge, methodologies	Adaptive test systems	All categories of specialists	Objective assessment of qualifications
Soft skills rating	Teamwork, emotional intelligence	AI assistants, psychometrics	Project teams	Identifying team potential
Digital footprint analysis	Professional development, activity	Big data analytics	All position levels	Comprehensive assessment of experience

Note: the effectiveness of methods is determined by the ratio of predicted and actual success indicators of candidates

Source: created by the author

Cooperation programmes with educational institutions have become integrated personnel development systems. Leading construction companies have implemented integrated educational ecosystems that combine theoretical training with practical training on real construction sites. Due to the use of dual education and the creation of corporate universities, it was possible to train highly qualified specialists in accordance with current market

needs. Digital metrics have substantially transformed the approach to HR management, enabling the move from a reactive to a proactive approach. Integration of personnel development systems with recruitment processes has formed a single ecosystem of human capital management. This systematic approach has become the foundation for long-term HR strategies, which are reflected in educational and career programmes (Table 3).

Table 3. Talent development systems in construction companies

Direction of development	Educational programmes	Practical component	Terms of preparation	Career trajectories
Technical specialists	Specialised courses, certifications	Project work, technical internships	6-12 months	Leading specialist
Project managers	Management programmes, MBA	Small project management	12-24 months	Project manager
BIM specialists	Digital modelling, programming	Development of digital models	8-16 months	BIM Coordinator
Design engineers	Engineering programmes, calculations	Designing elements	12-18 months	Chief designer
HR specialists	HR analytics, psychology	Recruitment, personnel development	6-12 months	HR director

Note: development programmes are adapted to the specifics of projects and strategic goals of companies

Source: created by the author

Digital technologies have opened up new opportunities in the formation of the personnel reserve. Talent management systems have created dynamic databases that allow tracking the professional progress of employees and planning their career growth. Predictive analytics help to identify potential leaders in time and create individual development trajectories. The formation of the HR brand of construction companies has received a holistic structure through a harmonious combination of digital and traditional communication channels. Professional content, in particular, virtual tours of construction sites and educational webinars, effectively demonstrates to potential candidates the technological level of the company and the scale of projects.

The development of a corporate culture focused on innovation and professional growth becomes a substantial factor in the attractiveness of the employer. The introduction of flexible work formats has substantially expanded the possibilities for attracting highly qualified specialists. The use of digital platforms for coordination allowed creating distributed teams that can work on joint projects regardless of the geographical location of participants. This opens up access to a global talent pool, increases the competitiveness of companies in the labour market, and contributes to the formation of effective project teams. The development of young professionals has acquired progressive consistency due to the introduction of comprehensive

professional growth programmes. Well-defined career trajectories, reinforced by educational modules and practical tasks, ensure a stable replenishment of the industry with new talents. Mentoring and coaching programmes promote the effective transfer of knowledge and experience from senior professionals to younger generations. International experience confirms the effectiveness of integrating modern and traditional models of personnel search and development in the construction sector. An integrated approach that combines digital technologies, educational initiatives, and investments in the HR brand allows consistently attracting qualified specialists and building strong project teams.

Development of professional competencies and talent management in construction

The examination of professional competencies in the construction industry revealed substantial changes in structural approaches to the development of human capital due to the introduction of digital technologies and increasing the complexity of modern construction projects. The analysis of the practices of international construction companies displayed the transition from conservative training models to integrated development systems that harmoniously combine technical expertise with managerial competencies. The methodology for assessing professional skills has also undergone substantial modernisation due to the use of digital tools for analysing and monitoring the

professional growth of employees. The formation of cross-functional teams in the construction sector has caused the need to develop interdisciplinary competencies among personnel. The experience of leading corporations in the industry shows the introduction of comprehensive educational programmes that cover technical, managerial, and digital competencies.

The integration of project management concepts into the training system develops practical skills through real participation in construction projects. The transformation of the construction industry associated with the introduction of BIM technologies and automated process management systems has substantially affected the structure of professional competencies. The results of the analysis of market requirements showed an increase in the need for specialists with thorough knowledge of working in a digital environment. The emergence of new construction technologies has set the task of creating systems of continuous professional development that will support and update the professional knowledge of employees. An empirical test confirmed the effectiveness of updating the personnel development system in the construction sector. According to M. Kallianan *et al.* (2023), an inclusive approach to talent management contributed to a 25% increase in

curriculum effectiveness. Systematisation of best practices and the creation of digital archives of project documentation ensured the formation of a single information space that simplifies the exchange of experience between different divisions of companies.

Innovative approaches such as structured knowledge bases and virtual laboratories have transformed PORR's teaching methods. The use of digital construction operations simulators provided for the modelling of complex technical processes in a safe environment and the development of digital doubles of construction equipment opened up new opportunities for remote training of technical personnel. According to the data of L. Hasselsteen *et al.* (2024), such measures resulted in a 40% reduction in the time required to find technical solutions. The analysis of the international practice of developing professional competencies allowed identifying key areas of educational transformation in the construction industry. The integrated professional training system focuses on technical design, construction project management, innovative technologies, engineering systems, and quality assurance. Table 4 details the structuring of educational programmes, digital tools, and approaches to assessing skills depending on the career trajectory of staff.

Table 4. Comprehensive system of professional competence development in the construction industry

Direction of development	Educational programmes	Digital tools	Evaluation methods	Career development
Technical design	BIM certification, design calculations	VR modelling, digital doubles	Technical tests, project portfolios	Chief designer
Construction management	MBA in construction, PMP	Project management systems, AI planning	Project KPIs, team evaluation	Project manager
Engineering systems	Specialised courses, certifications	Simulators, IoT platforms	Practical tasks, system audit	Technical director
Innovative technologies	R&D programmes, scientific research	Prototyping laboratories, AI analytics	Innovative projects, patents	Director of innovation
Quality management	ISO certification, lean practices	Quality control systems, big data	Audits, quality metrics	Quality Director

Note: development programmes are adapted to the strategic goals of companies and the specifics of projects

Source: created by the author

The digital transformation of Skanska's (2023) educational programmes has covered various aspects of staff training, with an emphasis on integrating modern technologies into the educational process. The use of VR simulations

for modelling construction processes increased the efficiency of mastering practical skills by 40%, which provided a substantial improvement in the quality of professional training. The organisation of specialised development centres

has helped accelerate talent training by combining technical expertise with managerial competencies. In addition, the introduction of agile methodology in learning processes has ensured the adaptability of educational programmes to dynamic changes in the technological requirements of the industry. In turn, Balfour Beatty integrated the Oracle HCM Cloud Platform for HR management. Automation of performance evaluation processes has reduced the cost of managing HR procedures by 18%. The system standardised the process of setting goals and evaluating their achievement. During the implementation, the need for additional investments in training HR specialists and technical support of the platform was revealed.

Hochtief's management competence development programmes (2023) were implemented in accordance with the levels of project responsibility. The developed system included advanced training modules on resource management, contractor coordination and risk management, which allowed for more structured training of project managers. The integration of practical cases from real construction projects contributed to the acquisition by participants of the necessary practical skills for effective management of construction processes. In addition, the implemented mentoring system ensured a combination of the transfer of managerial experience with the applied use of acquired knowledge in solving specific project tasks. The Learning Management System has become a catalyst for changes in the organisation of training at Vinci Construction (2023). Due to the introduction of artificial intelligence, it became possible to form personalised development trajectories based on the results of evaluating participants and the specifics of specific project tasks. As part of this system, Bouygues Construction (2023) developed a mobile application for accessing short training modules lasting 5-15 minutes, which contributed to the integration of training into the daily professional activities of employees.

The development of digital educational platforms has laid the foundation for the systematic introduction of innovative teaching methods in the construction industry. The Strabag practice (2023) demonstrated the high efficiency of regular innovative hackathons, during which project teams found new technical solu-

tions to optimise construction processes. The implemented system of innovation grants stimulated the creation and testing of new working methods, promoting innovation in the company. Strabag also deployed the SuccessFactors Learning platform for enterprise training. The implementation of the system has increased the completion rate of compulsory training programmes from 65% to 89%. Automation of certification processes has reduced the time spent on personnel evaluation by 25%. The main difficulties included the need to adapt content for mobile devices and ensure stable access to the system on construction sites. The Balfour Beatty competence matrix (2023) has optimised the career planning process by establishing clear criteria for employee professional growth. A regular assessment of the achievement of goals and the development of key skills was conducted on a quarterly basis and was based on an analysis of achievements in the implementation of project tasks. The automated digital progress tracking system contributed to the effective monitoring of the professional development of specialists and provided recommendations for further training. International certification of construction industry workers has opened up new opportunities for professional growth by standardising competence requirements according to ISO 17024.

The global experience exchange programme initiated by Vinci Construction (2023) attracted more than two thousand specialists from different regions to rotate between international projects, which ensured the dissemination of best practices and experience in the industry. Training in international competence centres contributed to the development of innovative BIM technologies and methodologies for managing complex infrastructure projects. The competence assessment process at Strabag's Assessment-center (2023) has undergone substantial changes due to the integration of integrated development metrics.

The improved assessment system provides for a multidimensional analysis of technical skills in fifteen key parameters of construction activities, assessment of managerial abilities through the implementation of specialised project tasks and measurement of innovation potential based on practical cases. Regular moni-

toring of results has created an objective array of data necessary for the strategic planning of staff development programmes. Therewith, the use of a digital assessment platform helped automate the processes of collecting and analysing data on the professional development of specialists. The formation of cross-functional teams for professional development has become a tool that has substantially strengthened the interdisciplinary exchange of knowledge in various areas of construction.

Cooperation between designers, engineers, and technical specialists on the implementation of innovative solutions has ensured the synergy of professional competencies. The activities of such teams demonstrated an increase in the speed of integration of new technical solutions by 35%, which indicates a high efficiency of cross-functional interaction. Measures to develop digital competencies of employees, due to the active introduction of the latest construction technologies, have become a priority. Training programmes focused on mastering BIM systems, IoT platforms and automated construction management systems ensured the readiness of personnel for technological changes in the industry. Certification in the field of digital technologies was integrated into the mandatory component of the professional development of builders, which contributed to the formation of a highly competitive staff.

The growing impact of digital competencies has led to the introduction of new approaches to evaluating the effectiveness of training programmes. Continuous development monitoring systems have become a crucial tool in the evolution of evaluating such programmes. The use of digital platforms to track progress made it possible to collect data on the practical application of knowledge gained during training in specific project tasks. The methodology for calculating the ROI of training initiatives was based on an analysis of the impact of competence growth on productivity and project implementation quality. The digitalisation of learning effectiveness assessment has created an information framework for integrating predictive analytics into talent management systems. This has substantially optimised career planning, especially in the construction industry.

For example, Strabag (2023) introduced machine learning algorithms that analysed historical data on employees' professional development and created forecasts to determine the most effective career growth trajectories. Combining data from project management systems and competence assessment allowed creating mathematical models that identify potential leaders among project team specialists. The use of augmented reality technologies in the Bouygues Construction (2023) training programmes has substantially expanded the possibilities of transferring practical skills. Interactive AR-based instructions integrated into mobile devices offered step-by-step algorithms for performing construction tasks directly on objects. The library of standard technical solutions, implemented in the format of AR models, provided standardisation of training approaches for production personnel. The use of these technologies in the installation of engineering systems has reduced the number of errors by 45% and accelerated the equipment installation process by 30%. Bouygues Construction has also developed its own talent management system based on the Talentsoft platform. Implementation has reduced the search time for internal candidates for project teams from 15 to 5 days. The system has improved the transparency of career opportunities, which has had a positive impact on the retention of key specialists. Among the disadvantages, the difficulty of integrating with existing project management systems was identified.

Neural network technologies have revolutionised the field of competence assessment by automating the analysis of learning outcomes. The artificial intelligence algorithms developed by Balfour Beatty processed data on the implementation of practical tasks and formed personalised recommendations for improving development programmes. Predictive analytics integrated into talent management processes has provided the ability to accurately predict the need to develop specific skills per construction project implementation plans.

Innovative strategies for retaining key employees in the construction sector

The examination of international construction companies demonstrates substantial changes in

approaches to personnel management, reflecting the integration of digital technologies and personalised development programmes. The practice of Vinci Construction has shown efforts to implement a multi-level motivation system that combines financial incentives related to the achievement of strategic project indicators and long-term professional development programmes. Motivation tools included basic wages, project completion bonuses, and long-term incentive programmes through stock options. The implementation of this strategy reduced staff turnover by 15% during the first year and contributed to the formation of stable project teams.

In the context of the digital transformation of management processes, Balfour Beatty has developed an integrated career planning platform that allows automating the processes of collecting data on employee competencies, creating individual training plans, and monitoring the achievement of professional goals. In turn, Bouygues Construction focused on analytical capabilities by implementing a comprehensive system for monitoring staff engagement. The use of algorithms for analysing activity in corporate systems, task performance, and quality of teamwork has reduced the number of unplanned layoffs by 18% due to the introduction of predictive analytics.

In terms of supporting employee well-being, Hochtief has implemented a comprehensive well-being programme that covers the areas of physical and psychological health. The programme included regular medical check-ups, access to sports facilities, psychological counselling, and stress management training. Further development of this area at Strabag was realised through the creation of a work-life balance system based on flexible work schedules and the ability to perform remotely. This approach has reduced the level of professional burnout by 18% and reduced the number of sick days by 22%.

The transformation of workspaces was particularly noticeable in Skanska's practice due to the introduction of the activity-based working concept. Recreation areas and meeting spaces were created on construction sites, and zoning was introduced in offices for individual work and team interaction. These measures contributed to a 16% increase in productivity and a 20% improvement in interagency communication, as quarterly surveys showed. A synthesis of the experience of implementing comprehensive personnel retention programmes in international construction companies during the study period is given in Table 5.

Table 5. Effectiveness of comprehensive personnel retention programmes in international construction companies (2020-2023)

Programme type	Key components	Performance metrics	High-quality results
Medical support and well-being	Corporate health insurance; psychological counselling; fitness programmes; stress management programmes	Reduction of sick days: 22%; reduction of professional burnout: 18%; increased satisfaction: 24%	Improving team spirit; increasing employee energy; increasing stress tolerance
Workspace transformation	Flexible work areas; ergonomic solutions; spaces for teamwork; recreation areas	Productivity growth: 16%; communication improvement: 20%; office space savings: 25%	Strengthening collaboration; Increasing creativity; Improving knowledge sharing
Digital engagement monitoring	Predictive analytics; Regular pulse surveys; Feedback system; AI analysis of behavioural patterns	NPS growth: +8 points; Retention increase: 12%; Unplanned layoffs decrease: 18%	Early detection of problems; Improved communication; Increased trust
Career development programmes	Individual development plans; mentoring system; cross-functional rotation; training programmes	Internal appointments: +25%; Turnover reduction: 15%; Upskilling: 35%	Formation of a personnel reserve; Development of leadership qualities; Growth of expertise

Note: NPS (Net Promoter Score) – Index of readiness to recommend a company as an employer; data are given on average for the companies under study

Source: created by the author

The development of professional competencies in the construction industry has become systematic due to the introduction of programmes for rotating specialists between projects of varying complexity, in particular, PORR. Focusing on digitalisation trends, the centres focus on investigating BIM technologies and automated control systems. Practical classes on virtual modelling of construction processes have substantially improved the quality of technical training of specialists. The integration of international standards has also made an important contribution to the development of professional competencies. Thereby, Ferroviál focused its efforts on implementing training programmes in sustainable (or “green”) construction and energy-efficient technologies, expanding the possibilities of implementing certified projects in the context of environmental responsibility. The company also introduced the graduated platform for personalised employee training. The system provided the formation of individual development trajectories based on the analysis of competencies. Implementation resulted in a 22% increase in staff engagement rates. The main challenges included the need to localise content and adapt training programmes for different regions of the company’s presence.

The introduction of analytical tools in HR processes has substantially transformed approaches to decision-making in the field of HR management. Analysing employee development data allowed companies to develop more accurate forecasts of training and professional development needs. The use of digital technologies for personnel evaluation has contributed to the timely identification of needs for professional growth, as well as optimisation of educational programmes. The practice of forming project teams through rotation between construction sites has shown a number of advantages in training multidisciplinary specialists. This approach allows not only to expand both technical and managerial competencies of employees but also to open up new career prospects.

Mentoring programmes have demonstrated high efficiency in preserving industrial knowledge and accelerating the professional development of young professionals. The introduction of international standards in the personnel

training system reorients the content of professional training in the construction industry. Training centres of construction companies focus on training specialists in accordance with the global requirements of project management. Environmental construction and energy efficiency programmes have created new opportunities for implementing projects that meet the goals of sustainable development, thereby strengthening the industry’s position in the context of environmental transformation.

Adaptation of international HR practices in Ukrainian construction companies

Improving personnel motivation and development systems in Ukrainian construction companies requires profound changes focused on applying the successful experience of international corporations. Progressive mechanisms of surcharges for the duration of work were introduced to reduce the turnover of engineering and technical personnel, as well as bonuses depending on the results of construction projects completion. The retention of key specialists provided for the implementation of long-term professional development programmes, which included co-financing training in leading higher education institutions and payment for obtaining international certificates.

Strengthening the technical professionalism of employees was ensured by the creation of corporate educational centres on the basis of existing construction sites. Improving the quality of construction work was achieved through the introduction of internal technical standards and the introduction of regular personnel certification. A structured adaptation programme was developed to integrate young professionals into production processes, which provided for gradual involvement in project teams under the supervision of experienced engineers. Systematisation of technical knowledge took place through the creation of databases of standard solutions and documentation of effective construction practices. The development of managerial competencies of project managers was implemented through internships in various departments of the company with a gradual increase in the complexity of the objects they managed. The training of the personnel reserve was accompanied by

individual development plans and regular rotation between projects of various scales and complexity. In parallel to that, the digitalisation of construction processes took place with the involvement of BIM systems and training of personnel on the example of real projects of the company.

A comprehensive approach to staff supports included measures to prevent professional burnout, including additional rest after completing difficult stages of work. Psychological support programmes and training sessions on load management were introduced to increase the stress tolerance of employees. Medical care was expanded due to the improvement of insurance coverage and the organisation of regular preventive examinations, considering the specifics of work in the construction sector. Attracting young professionals to the industry was based on creating long-term partnerships with specialised educational institutions and a system of paid internships for final-year students. The growth of career attractiveness in the construction sector was ensured by transparent criteria for professional growth and an effective mentoring system. The exchange of international experience was organised through internship programmes of Ukrainian specialists in leading European companies with further integration of the experience gained into local projects. Using these recommendations, Ukrainian construction companies will be able to improve their own management practices based on the experience of global companies.

DISCUSSION

The conducted research revealed patterns in the transformation of personnel management in the construction industry under the influence of innovative HR strategies. The experience of leading international construction companies shows the transition from a traditional approach to integrated digital solutions and automated personnel assessment systems. H. Nazarova *et al.* (2022) and G. Taher (2021) established that the implementation of Industry 4.0 technologies requires the acquisition of new professional competencies. According to the data, 74% of construction companies faced the problem of insufficient qualification of personnel during the implementation of innovations. The examples of Skanska and VINCI demonstrate the

effectiveness of investing in digital learning through the creation of corporate educational centres and distance learning systems. As a result, these companies achieved a 40% increase in productivity and a 25% reduction in project implementation time. K. Piwowar-Sulej (2021) reviewed the relationship between HR strategies and the competitiveness of construction organisations, confirming in the practices of leading companies. For example, Hochtief uses a staff assessment system based on 15 key parameters, supplemented by cross-functional training and individual career development programmes. This resulted in a 35% reduction in staff turnover and a noticeable improvement in the quality of project execution.

Papers of P.C. Bahuguna *et al.* (2023) and R. Paulet *et al.* (2021) indicated an increase in the importance of “green” HR practices. Construction companies have adapted these approaches through environmental training and motivation systems. Bouygues Construction successfully implemented the employee environmental certification programme and bonus systems for environmental impact reduction initiatives, which led to a threefold increase in submitted eco-initiatives and the involvement of 65% of employees in the programme. PORR has created specialised “green teams” that implement environmental innovations 40% more efficiently. Analysis of the use of artificial intelligence in HR processes presented by A.M. Votto *et al.* (2021), confirmed its value in the construction industry. For example, Vinci Construction automated the initial selection of candidates using AI systems, optimising recruitment time by 32%. Balfour Beatty uses analytical platforms to create reference profiles of employees for key specialisations.

Remote and hybrid control models described by N. Malyarchuk (2024) and G.V. Sereda & V.A. Nesteruk (2024), adapted to the specific features of project activities in construction. The transition of administrative staff to flexible working hours has reduced office maintenance costs without losing efficiency. Digital coordination platforms and hybrid work formats were introduced for project teams. Turner Construction has implemented a flexible schedule model, increasing staff satisfaction by 45%. The findings of O.A. Doronina &

D.S. Polgul (2021) draw attention to the transformation of HR processes, which is becoming relevant in the construction sector. This process was manifested in the integration of new approaches to the motivation and professional development of personnel. The analysis showed a change in the values of employees, who increasingly prefer opportunities for professional growth over the level of wages. An example is BAM Group, which introduced a 360-degree assessment system that provided comprehensive feedback and allowed effectively planning the individual development trajectory of employees.

Of special importance were the issues of labour safety, which became the object of a detailed examination by K. Wasilkiewicz Edwin *et al.* (2024) and L. Hasselsteen *et al.* (2024). In the construction industry, the introduction of VR technologies for safety training, as Bouygues Construction did, has reduced the number of errors by 45%. The combination of regular trainings, mentoring programmes, and digital instructions has reached more than 3,000 technical specialists, providing training for the use of new safe approaches in construction.

The results of a study on digital transformation of HR processes in the construction industry revealed a correlation with the results published by F.L. Cooke *et al.* (2020) and L.B.P. da Silva *et al.* (2022). The mentioned authors, after analysing 93 scientific articles, identified 13 key areas of transformation of human resource management in the context of the Fourth Industrial Revolution (Industry 4.0). The approaches to implementing digital platforms for personnel training and development in construction companies identified in this study confirm the importance of these areas but demonstrate the specific features of their application in the construction sector. In particular, enterprises in this industry face the need for a longer period of adaptation of digital tools, which is due to the technical features of production processes.

Equally important was the study by C. Tanova & S.W. Bayighomog (2022), which found a correlation between “green” HR practices and organisational performance. The environmental transformation of the construction industry has been reflected in the introduction of energy-efficient construction training programmes,

as Ferrovia did, reaching 65% of employees. Digitalisation has become a strategic tool for improving productivity, which has been analysed in detail by B. Nikmehr *et al.* (2021). The introduction of BIM technologies and IoT systems in construction organisations such as Skanska has reduced the duration of project implementation by 25%. This confirms the value of an integrated approach to digital transformation. Issues of implementing HR practices starting from the planning stage were analysed by J. Trullen *et al.* (2020). The researchers focused on the importance of interaction between HR departments and line managers for successful innovation adoption. The experience of involving employees in implementing changes in construction projects has shown an increase in productivity by a third.

A paper of V. Pereira *et al.* (2023), which covered more than 13 thousand publications, highlighted the use of artificial intelligence in HR management. Construction companies actively use predictive analytics to forecast personnel needs. Digital training platforms have implemented individualised approaches to developing competencies, and AI systems for recruiting have reduced the recruitment time by half. Similarly, the study conducted by S.A. Alerasoul *et al.* (2022), devoted to organisational learning and knowledge management, identified analogous trends in systematising and documenting best practices. However, in contrast to the generalised conclusions of the authors, the results of this study indicate that in the construction industry, structuring the accumulated experience requires the creation of specialised industry classifiers and evaluation methods. In addition, the empirical experience of Royal BAM Group in using knowledge-sharing platforms aimed at accelerating the integration of new employees confirms the relevance of the results obtained. This experience highlights the need for substantial localisation of such platforms following the characteristics of regional construction markets.

A survey of 505 builders conducted by X. Meng & A.H.S. Chan (2024), underlined the importance of safety culture in shaping employee behaviour. In the practical activities of construction companies, this was implemented through trainings and safety monitoring systems. The

development of mentoring programmes at Balfour Beatty has helped raise awareness of the importance of complying with safety standards. Social interaction between employees was identified to be a key factor in shaping the safety culture. The analysis indicated the substantial importance of innovative HR strategies for the development of the construction industry. The results demonstrate a close relationship between technological innovations, professional growth of employees, and the overall efficiency of construction organisations, which creates the basis for further improvement of human resource management practices.

CONCLUSIONS

The examination of the transformation of HR processes in the construction industry for the period 2020-2023 revealed substantial changes in personnel management systems due to the integration of digital technologies. The results of the introduction of artificial intelligence in recruitment processes showed a reduction in recruitment time by 32% and an improvement in the quality of candidate selection by 45%. Automation of primary screening contributed to a threefold increase in the number of high-quality processed resumes with the same composition of the HR team. The analysis of measures for the development of professional competencies established the effectiveness of using VR simulations and digital doubles in training programmes for personnel. The use of virtual simulators for technical operations reduced the number of production errors by 45% and reduced the training period by 30%. In addition, cross-functional personnel development programmes accelerated the implementation of new technical solutions by 35%. The introduction of cross-functional teams also ensured the accelerated adoption of innovative technologies.

The study on motivation systems has shown the effectiveness of a multi-level approach to employee incentives. Integration of project bonuses and long-term incentive programmes, in particular, through options, reduced staff turnover by 15%. The transformation of the workspace founded on the activity-based working principle helped to reduce the level of professional burnout by 18% and increase labour

productivity by 16%. The development of well-being programmes, which included regular medical examinations and psychological consultations, reduced the number of sick days by 22%. The results obtained allowed creating a methodological basis for implementing innovative HR strategies in the construction industry. The developed recommendations include a plan for step-by-step digital transformation of HR processes for construction companies. In particular, these include the introduction of artificial intelligence systems for automating recruitment, the formation of digital training platforms, and the development of predictive HR management. Integrated Personnel Development programmes were based on the integration of VR technologies and approaches to cross-functional training. The use of digital competence monitoring tools allowed creating an objective database for personnel development planning.

Competence assessment systems covered the analysis of technical skills in 15 key parameters of construction processes and the assessment of managerial abilities through the implementation of project tasks. The introduction of regular competence monitoring contributed to the creation of a database for targeted curriculum planning. In addition, the organisation of the international exchange of experience between construction projects strengthened knowledge exchange and accelerated the introduction of innovative approaches in construction. Therewith, the focus of the study mainly on the practices of large international construction companies narrowed the opportunity to highlight the specifics of small and medium-sized businesses in the industry. Further research requires attention to the implementation of HR strategies in medium and small construction enterprises, considering organisational and financial characteristics.

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Інноваційні стратегії розвитку управління персоналом на прикладі будівельної сфери

Анотація. Зростання складності будівельних проектів у поєднанні з цифровою трансформацією галузі зумовлює необхідність модернізації систем управління персоналом, що є ключовим фактором забезпечення конкурентоспроможності будівельних підприємств. Метою дослідження була розробка комплексної цифрової системи управління людськими ресурсами (HR), покликаної підвищити ефективність HR-процесів в умовах динамічних технологічних змін. Методологічне підґрунтя роботи базувалося на аналізі корпоративної документації 8 міжнародних будівельних компаній за період 2020-2023 рр., яка послужила основою для оцінки та впровадження інноваційних HR-стратегій. Серед найважливіших досягнень – інтеграція штучного інтелекту в процеси рекрутингу, що дозволило скоротити час набору персоналу на 32 % та суттєво покращити якість відбору кандидатів (зростання на 45 %). Використання симуляцій віртуальної реальності (VR) у навчальних програмах знизило рівень помилок при виконанні складних виробничих операцій на 45 %. Крім того, розроблена система моніторингу компетенцій, заснована на 15 параметрах будівельних процесів, сприяє формуванню референтних профілів фахівців. Трансформація робочого простору на основі діяльнісного принципу роботи позитивно вплинула на рівень професійного вигорання, знизивши цей показник на 18% і підвищивши продуктивність праці на 16 %. Впроваджені програми підтримки благополуччя зафіксували скорочення кількості лікарняних на 22 %, а розвиток крос-функціональних команд прискорив впровадження інновацій на 35 %. Сукупність цих результатів створює практичне підґрунтя для модернізації HR-процесів у будівельній галузі. Матеріали дослідження можуть бути використані для розробки програм професійного розвитку, адаптації інноваційних методів управління персоналом та формування стратегій цифрової трансформації в контексті специфіки будівельної галузі

Ключові слова: цифрова трансформація; професійні компетенції; крос-функціональні команди; предиктивна аналітика; well-being програми