

Electronic scientific and practical journal

INTELLECTUALIZATION OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

#37(2026)
June '26



WWW.SMART-SCM.ORG

ISSN 2708-3195

DOI.ORG/10.46783/SMART-SCM/2026-37

ISSN 2708-3195



9 772708 319005

Electronic scientific and practical publication in economic sciences

Electronic scientifically and practical journal “Intellectualization of logistics and Supply Chain Management” included in the list of scientific publications of Ukraine in the field of economic sciences (category “B”): **Order of the Ministry of Education and Culture of Ukraine dated June 11, 2026 No. 928 (Appendix 13 item 205).**

Cluster: Economic Transformation, Business and Administration

Specialties: C1 – Economics and International Economic Relations (by specializations)

D3 – Management

D5 – Marketing

ISSN 2708-3195

DOI: <https://doi.org/10.46783/smart-scm/2026-37>

The electronic magazine is included in the international scientometric databases:

Index Copernicus, Google Scholar

Released 6 times a year

№ 37 (2026)

June 2026

Kyiv - 2026

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In 2020, the International Center for Periodicals (ISSN International Center, Paris) included the Electronic Scientific and Practical Edition “Intellectualization of logistics and Supply Chain Management” in the international register of periodicals and provided it with a numerical code of international identification: ISSN 2708-3195 (Online).

Recommended for dissemination on the Internet by the Academic Council of the Department of Logistics NAU (No. 7 of February 26, 2020). Released 6 times a year. Editions references are required. The view of the editorial board does not always coincide with that of the authors.

Electronic scientifically and practical journal “Intellectualization of logistics and Supply Chain Management” included in the list of scientific publications of Ukraine in the field of economic sciences (category "B"): **Order of the Ministry of Education and Culture of Ukraine dated June 11, 2026 No. 928 (Appendix 13 item 205).**

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DOI: <https://doi.org/10.46783/smart-scm/2026-37>
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DOI: <https://doi.org/10.46783/smart-scm/2026-37-4>

UDC 005.95/.96:004.8:502.131.1:339.9
JEL Classification: M12, M14, M15, O15, O33, Q56.

Received: 2026-05-10
Accepted: 2026-06-21
Published: 2026-06-30

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THE READINESS OF HUMAN CAPITAL FOR DIGITAL AND GREEN TRANSFORMATION IN CONDITIONS OF INTERNATIONAL INSTABILITY

Oksana Kyrylenko, Anton Borysiuk. *"The readiness of human capital for digital and green transformation in conditions of international instability".* The article examines the managerial dimension of human capital readiness for the simultaneous digital and green transformation of organisations operating under international instability. A sharp practical manifestation of such instability is the post-war reconstruction of Ukraine, which combines unprecedented human-capital losses, EU-accession requirements and a concurrent digital and green transition. The study synthesises open data from Eurostat, the OECD, the World Economic Forum, the European Commission and the International Air Transport Association with a structured review of the literature on AI readiness, green human resource management and human-machine collaboration. Methodologically, it applies a multi-criteria weighted approach with expert-based normalised weights and an equal-interval interpretation scale. The analysis shows that the main barrier to combined transformation is not a lack of technology or capital but the gap between employees' existing competencies and the requirements of a digital, AI-oriented and environmentally responsible environment. To turn readiness into a practical tool, an integrated human capital readiness index (HCR) is proposed, combining six components: digital readiness; readiness for AI and automation; green/ESG readiness; adaptive readiness; managerial readiness; and social and motivational readiness. The article defines a system of indicators and data sources, a procedure for calculating partial and integrated scores, three weighting approaches and a five-level interpretation scale linking quantitative results to managerial actions. Applicability is demonstrated using internationally integrated, safety-critical sectors – aviation and logistics – as reference cases for post-war reconstruction. Directions for further empirical validation are outlined.



Keywords: workforce competencies, AI literacy, environmental and social governance, reskilling, change management, integrated human capital readiness index, post-war reconstruction

Оксана Кириленко, Антон Борисюк. «Готовність людського капіталу до цифрової та зеленої трансформації в умовах міжнародної нестабільності». У статті розглядається управлінський вимір готовності людського капіталу до одночасної цифрової та зеленої трансформації організацій, що діють в умовах міжнародної нестабільності. Гострим практичним проявом такої нестабільності є повоєнне відновлення України, яке поєднує безпрецедентні втрати людського капіталу, вимоги євроінтеграції та одночасний цифровий і зелений перехід. Дослідження синтезує відкриті дані Євростату, ОЕСР, Всесвітнього економічного форуму, Європейської Комісії та Міжнародної асоціації повітряного транспорту зі структурованим оглядом літератури з готовності до штучного інтелекту, зеленого управління людськими ресурсами та співпраці людини й машини. Методологічно застосовано багатокритеріальний зважений підхід із нормалізацією ваг на основі експертних оцінок і шкалою інтерпретації з рівними інтервалами. Аналіз показує, що головною перешкодою комбінованої трансформації є не брак технологій чи капіталу, а розрив між наявними компетенціями працівників і вимогами цифрового, орієнтованого на штучний інтелект та екологічно відповідального середовища. Для перетворення поняття готовності на практичний інструмент запропоновано інтегральний індекс готовності людського капіталу (HCR), що поєднує шість компонентів: цифрову готовність; готовність до штучного інтелекту та автоматизації; зелену/ESG-готовність; адаптивну готовність; управлінську готовність; соціально-мотиваційну готовність. Визначено систему показників і джерел даних, процедуру розрахунку часткових та інтегрального балів, три підходи до зважування і п'ятирівневу шкалу інтерпретації, що пов'язує кількісні результати з управлінськими діями. Практичну застосовність продемонстровано на прикладі міжнародно інтегрованих, критично важливих секторів – авіації та логістики – як референсних для повоєнного відновлення. Окреслено напрями подальшої емпіричної перевірки.

Ключові слова: компетенції робочої сили, грамотність у сфері штучного інтелекту, екологічне та соціальне управління, перекваліфікація, управління змінами, інтегральний індекс готовності людського капіталу, повоєнне відновлення.

Introduction. Contemporary organisations operate in an environment of simultaneous digital, green, social and geo-economic transformation. The spread of artificial intelligence, automation, robotic systems, digital platforms, ESG reporting, decarbonisation and new regulatory requirements changes not only production and management technologies but also the content of work, the structure of competencies, the requirements placed on managers and the nature of interaction between people and technology.

Digital and green transformation can no longer be viewed as two isolated processes. In European Union policy they are increasingly described as a twin transition, in which digital

technologies are expected to accelerate decarbonisation, resource efficiency and sustainable business models, while the green transition requires new digital, analytical and managerial skills. In its State of the Digital Decade 2025 report, the European Commission stresses that the EU remains far from its targets for artificial intelligence, digital skills, semiconductors and the uptake of key digital technologies by business (European Commission, 2025a).

The sharpest contemporary manifestation of international instability is the full-scale war and the post-war reconstruction of Ukraine. According to the joint assessment of the Government of Ukraine, the World Bank, the European Commission and the



United Nations, the country's recovery is a long-term process tied to European Union accession and to the "Ukraine Economy of the Future" strategy, in which investment in human capital and social resilience is identified among the key priorities (World Bank et al., 2026). At the same time, the war has caused unprecedented losses of human capital – migration, demographic decline, and the disruption of educational and career trajectories – while structural labour-market problems persist (Tony Blair Institute, 2025). Ukrainian researchers emphasise that the restoration of human capital should rely on digitalisation and the anticipatory development of competencies (Novikova, Zaloznova & Azmuk, 2022; Kruhlov & Tereshchenko, 2023). This makes Ukraine not a peripheral but an illustrative case: recovery here objectively requires a simultaneous digital and green transformation under conditions of heightened external risk – precisely the combination that is the subject of this study.

It is especially important that human capital becomes not an auxiliary resource of transformation but its central precondition. At the same time, the digital transformation of organisations is entering a new phase associated with artificial intelligence. International instability – wars, geopolitical fragmentation, energy crises, supply-chain disruptions, labour migration and changing regulatory requirements – intensifies these processes. A scientific and practical problem arises: organisations are compelled to implement digital, AI-oriented and green changes simultaneously, while human capital is often unprepared for such a complex transition. This manifests in a shortage of digital and AI-oriented skills, a weak understanding of ESG practices, employee resistance, a deficit of managerial competencies, insufficient adaptability and the absence of a systematic reskilling policy.

In the current academic literature, the problem of human capital readiness for transformation is examined through several

interrelated strands. The first concerns organisational readiness for artificial intelligence: systematic reviews show that such readiness is not a purely technological characteristic but is formed at the intersection of technological capabilities, governance structures, staff competencies and external conditions (Ali & Khan, 2025). The second is green human resource management (Green HRM), understood as a set of practices that foster environmentally responsible employee behaviour, green competencies and organisational resilience (Lawter & Garnjost, 2025; Alrifae, 2026). The third combines the digital and green logics of people management in the concept of digital green HRM. The fourth concerns human–AI collaboration: according to Deloitte (2026), organisations that deliberately redesign roles, workflows and decision-making around such collaboration are more likely to obtain higher returns on their technology investments. The fifth is the regulatory dimension of AI literacy: Article 4 of the EU Artificial Intelligence Act requires providers and deployers of AI systems to ensure a sufficient level of such literacy among their staff (European Commission, 2025b; European Union, 2024).

Despite the multiplicity of approaches, a methodological gap remains. Existing instruments mostly measure separate slices: digital skills and digital maturity; AI readiness as the intersection of technology, governance and competencies (Ali & Khan, 2025); Green HRM practices and their link to performance (Lawter & Garnjost, 2025; Alrifae, 2026). Composite indices of human capital readiness for digital transformation are mostly built on a limited number of dimensions – for example, Farlis et al. (2025) apply principal component analysis across four dimensions. By contrast, an integrated assessment of readiness for a simultaneous digital, green and AI-oriented transformation under conditions of international instability and post-war reconstruction remains insufficiently studied, which defines the research niche of this study.



The aim of the article is to improve the theoretical and methodological approach to managing human capital readiness for the digital and green transformation of organisations under conditions of international instability. To achieve this aim, the following objectives are set: to summarise current scientific approaches to studying digital, green and AI-oriented transformation; to analyse open statistical data on digital skills, AI adoption and competence barriers to business transformation; to propose a system of human capital readiness components; to develop a procedure for calculating a composite readiness index; and to define the managerial interpretation of assessment results and illustrate it for reference, internationally integrated sectors of post-war reconstruction.

Theoretical Framework and Methods.

Since the article is theoretical and methodological in nature, the methodological section sets out the logic of the proposed instrument rather than an empirical sampling procedure. To turn the concept of human capital readiness into a practical management tool, the study employs an integrated human capital readiness index (hereafter HCR). Its construction rests on the principle of multi-criteria assessment, according to which the overall level of readiness is formed as a weighted sum of scores across key components.

At the first level, six readiness components are assessed: digital readiness; readiness for artificial intelligence and automation; green/ESG readiness; adaptive readiness; managerial readiness; and social and motivational readiness. At the second level, each component is detailed by specific indicators that can be assessed through questionnaires, testing, analysis of HR documents, expert judgement or corporate statistics. The integrated index is calculated as:

$$HCR = \sum_i W_i \cdot S_i \quad \sum_i W_i = 1,$$

where HCR is the integrated human capital readiness index; W_i is the weight of component i ; and S_i is the normalised score of component i . The component score is obtained as:

$$S_i = \sum_j W_{ij} \cdot P_{ij}, \quad \sum_j W_{ij} = 1 \quad (\text{for each } i)$$

where W_{ij} is the weight of indicator j within component i ; and P_{ij} is the score of indicator j on a scale from 1 to 5. Since $P_{ij} \in [1; 5]$ and the weights of indicators and components within each level sum to one, both S_i and HCR are convex combinations and are therefore bounded to the interval $[1; 5]$, which makes the results directly comparable across organisations and over time.

The component weights W_i can be determined in three ways. The first is equal weighting, where all components are considered equally important; this is a simple tool for initial testing of the model but does not reflect the specifics of a particular organisation. The second is expert normalisation: experts rate the importance of each component on a scale from 1 to 10, and the weight is calculated as the share of the average expert score in the total sum,

$$W_i = \frac{E_i}{\sum_i E_i},$$

where E_i is the average expert score of component i . The third is the analytic hierarchy process (AHP) with pairwise comparisons; it is more rigorous and suitable for in-depth empirical research. For a study of a theoretical and methodological nature, expert normalisation is applied as a transparent, comprehensible and sufficiently reliable approach for a first approbation of the index.

Applying weights by the "importance" of components raises a methodological question: since the most problematic components may have lower weights, their contribution to the aggregate index can

"blur" the overall picture. To avoid this masking effect, a two-level interpretation logic is built into the instrument. The integrated *HCR* indicator is used only as a generalised signal for benchmarking and communication, whereas managerial decisions are taken on the basis of the component profile – the vector of partial scores S_j and the indicators P_{ij} . In addition, a minimum-threshold rule is introduced: any component whose score falls into the two lowest bands of the scale ($S_j < 2.60$) requires priority intervention regardless of its weight. Thus, weighting by importance reinforces rather than conceals the signal of a deficit in strategically priority components, while low-weight weak areas do not drop out of the analysis.

The interpretation scale divides the range [1; 5] into five bands of equal width 0.80. To avoid ambiguity at the boundaries, the bands are defined as half-open intervals [lower bound; upper bound), in which the upper bound belongs to the next band (the last band being closed). Each band is linked to a managerial interpretation (Table 4).

A number of limitations should be acknowledged: the example below is illustrative and uses conditional values, and the index itself has not yet undergone empirical validation; the weights in the example were obtained by expert normalisation to demonstrate the procedure. To move from illustration to pilot application, it is advisable to involve a small expert panel (5–7 specialists). These limitations define directions for further empirical research and do not affect the internal consistency of the calculation procedure.

Results and Discussion.

To substantiate the need for an integrated human capital readiness index, it is useful to analyse four groups of open data: the digital skills of the population, AI use by enterprises, competence barriers to business transformation, and the needs of the green transition.

First, Eurostat shows that in 2025 only 60% of the EU population aged 16–74 had at least basic digital skills – 20 percentage points below the 2030 Digital Decade target (80%) and with a notable increase from 54% in 2021 and 56% in 2023. At the same time, there is considerable cross-country variation: the Netherlands reached 84%, Ireland 83%, and Denmark and Finland 81% each, whereas Romania had only 32% and Bulgaria 38% (Eurostat, 2025a). This means that digital readiness cannot be taken for granted even in developed EU economies, and the unevenness of skills places organisations at different starting levels of staff readiness.

Second, AI adoption in the EU is growing rapidly but still covers a minority of enterprises. In 2025, 20.0% of EU enterprises with 10 or more employees used AI technologies; in 2024 the figure was 13.5%, and in 2021 it was 7.7% (Eurostat, 2025b). Thus, over four years the share of such enterprises more than doubled. At the same time, among enterprises that had ever considered adopting AI, the most common reason for not doing so in 2025 was a lack of relevant expertise, reported by 70.9% (Eurostat, 2025b). AI therefore creates not only technological but also organisational and human-capital challenges.

Third, according to the World Economic Forum, employers expect 39% of core skills to change by 2030; this figure, although high, has declined from 44% in 2023, which is associated with growing investment in reskilling. Skills shortages are named the greatest barrier to business transformation: 63% of employers identify them as the main obstacle for 2025–2030, and 85% plan to prioritise upskilling their staff (World Economic Forum, 2025). This indicates that a competence deficit is becoming a strategic barrier to organisational transformation.

Fourth, the green transition requires new skills. The OECD shows that national green-transition strategies place strong emphasis on upskilling, reskilling and lifelong learning (OECD, 2025). Cedefop likewise stresses that



the European Green Deal will affect all sectors and occupations, although the intensity and direction of this impact will vary, which requires studying the consequences for jobs, skills and vocational education and training (Cedefop, n.d.).

The statistical justification of the human capital readiness gap is summarised in

Table 1. A sectoral view of aviation and logistics is presented separately – sectors convenient for illustrating the problem because they combine international integration, high safety standards, technological complexity and a strong influence of environmental regulation.

Table 1 – Statistical justification of the human capital readiness gap

| Analytical block | Key data | Managerial implications |
|--|--|---|
| Digital skills | 60% of the EU population aged 16–74 have basic digital skills; the 2030 target is 80% (Eurostat, 2025a). | Organisations need a differentiated diagnosis of staff digital readiness. |
| AI adoption | 20.0% of EU enterprises used AI in 2025; 13.5% in 2024; 7.7% in 2021 (Eurostat, 2025b). | Adoption is accelerating, but human capital is not always ready to scale the technology. |
| Skills gaps | 63% of employers name skills shortages the main barrier to transformation; 85% prioritise upskilling (World Economic Forum, 2025). | Competence development must be part of strategic management, not only an HR function. |
| Green transition | The OECD and Cedefop emphasise the need for green skills, reskilling and lifelong learning (OECD, 2025; Cedefop, n.d.). | ESG and the green transition require a systematic workforce policy. |
| Aviation and logistics (sectoral view) | Automation and AI adoption are accelerating; workforce transformation is identified as a critical condition for the development of air cargo (IATA, 2025). | Internationally integrated, safety-critical sectors require anticipatory competence development and new models of human–system cooperation. |

Source: compiled by the authors based on Eurostat (2025a; 2025b), World Economic Forum (2025), OECD (2025), Cedefop (n.d.), IATA (2025).

In its document "The Future of Air Cargo Vision 2025", the International Air Transport Association notes that automation and AI adoption are accelerating, while workforce transformation is becoming a critical condition for the further development of the industry and requires upskilling and new models of cooperation between operators and intelligent systems (IATA, 2025). This example is important not only for aviation. In the Ukrainian context, aviation and logistics are directly linked to the post-war reconstruction of infrastructure, integration into the EU Common Aviation Area and sustainability requirements, so it is precisely here that the human capital readiness gap manifests most acutely. This reflects a broader

regularity: in internationally integrated sectors, digitalisation, automation, AI and sustainability cannot be implemented without rethinking competencies, roles and models of interaction between people and intelligent systems. Aviation can therefore be regarded as a reference sector for analysing human capital readiness in other industries – logistics, finance, public administration, education, manufacturing and services.

The six components of the proposed integrated human capital readiness index, together with their content, indicative measures and possible data sources, are presented in Table 2. A specific organisation may adapt this list depending on its sector,



size, level of international integration and the nature of the transformation.

Table 2 – Components and indicators of the integrated human capital readiness index

| Code / component | Content and indicators | Possible data sources |
|---------------------------------------|---|--|
| C1. Digital readiness | Ability to work with digital tools, platforms, data and digital communication: basic digital skills; data literacy; use of digital platforms; cyber-hygiene; willingness to master new tools. | Testing; self-assessment; IT statistics; HR data |
| C2. Readiness for AI and automation | Readiness to interact with AI, automation and robotic solutions: AI literacy; practical use; risk awareness; ability to verify outputs; readiness for human–machine collaboration. | Questionnaires; practical tasks; manager assessment; compliance checks |
| C3. Green/ESG readiness | Ability to follow environmentally responsible practices and understand ESG requirements: knowledge of ESG principles; understanding of the environmental impact of work; participation in environmental practices; willingness to change behaviour. | Test; questionnaire; operational data; interviews |
| C4. Adaptive readiness | Ability to act under uncertainty, crises, international risks and rapid change: openness to change; learning flexibility; experience in crisis conditions; tolerance of uncertainty; international adaptability. | Questionnaire; manager assessment; HR data; psychometric scale |
| C5. Managerial readiness | Ability of management to organise, communicate and steer the transformation: existence of a strategy; leadership engagement; change-management skills; training programmes; linkage of training to KPIs. | Document analysis; expert assessment; 180/360 feedback; HR documents |
| C6. Social and motivational readiness | Trust, motivation, acceptance of change, reduced fear of replacement by AI or robotisation; perception of the fairness of change; willingness to participate in transformation projects. | Questionnaires; HR data; interviews; focus groups |

Source: developed by the authors.

The proposed components draw on existing literature: C1 aligns with the measurement of digital skills and digital maturity (Eurostat, 2025a); C2 with research on organisational AI readiness (Ali & Khan, 2025) and the regulatory requirements of AI literacy (European Union, 2024); C3 with the concept of Green HRM (Lawter & Garnjost, 2025; Alrifae, 2026); C5 with approaches to change management and digital HRM; and C6 with models of employees' perception and acceptance of technology.

To demonstrate how the methodology works, Table 3 provides a conditional example of assessing an organisation undergoing a combined digital–green transformation. The weights were obtained through expert normalisation; the component scores S_i are weighted averages of the corresponding indicators on a scale from 1 to 5.



Table 3

Example of expert weighting and HCR calculation

| Component | Average expert score E_i | Weight W_i | Score S_i | $W_i \times S_i$ |
|---------------------------------------|----------------------------|--------------|-------------|------------------|
| C1. Digital readiness | 8.5 | 0.17 | 3.60 | 0.612 |
| C2. Readiness for AI and automation | 8.0 | 0.16 | 2.80 | 0.448 |
| C3. Green/ESG readiness | 7.0 | 0.14 | 2.40 | 0.336 |
| C4. Adaptive readiness | 9.0 | 0.18 | 3.20 | 0.576 |
| C5. Managerial readiness | 9.5 | 0.19 | 3.00 | 0.570 |
| C6. Social and motivational readiness | 8.0 | 0.16 | 2.70 | 0.432 |
| Total / HCR | 50.0 | 1.00 | – | 2.974 |

Source: developed by the authors (conditional example; the final HCR is rounded to 2.97).

In the example, HCR = 2.97 out of 5, which corresponds to a basic level of readiness. The weakest components are green/ESG readiness ($S_i = 2.40$), social and motivational readiness (2.70) and readiness for AI and automation (2.80). Under the minimum-threshold rule, green/ESG readiness falls into a band requiring priority intervention. This

means that management should not begin the transformation with the large-scale deployment of complex AI- or ESG-based solutions without prior training, communication, trust-building and clarification of staff roles. The interpretation scale is presented in Table 4.

Table 4 – Interpretation scale of the integrated human capital readiness index

| HCR value | Readiness level | Managerial interpretation |
|--------------|-----------------|---|
| [1.00; 1.80) | critically low | The organisation is not ready for systemic transformation. |
| [1.80; 2.60) | fragmentary | Individual skills exist, but there is no systemic readiness. |
| [2.60; 3.40) | basic | Transformation can begin, but significant gaps remain. |
| [3.40; 4.20) | developed | Core components are in place; targeted improvements are needed. |
| [4.20; 5.00] | strategic | Human capital is a driving force of transformation. |

Source: developed by the authors. Note: the upper bound of a band belongs to the next band (except the last, closed band); each band is 0.80 wide.

The advantage of the index is that it allows a move from general statements about upskilling to a specific managerial diagnosis. If the level of digital readiness (C1) is weak, the organisation needs basic programmes in digital literacy, data literacy, cyber-hygiene and work with digital platforms. If C2 is weak, AI literacy, training in prompt engineering, verification of AI outputs, rules of human oversight and responsible use are required. If

C3 is weak, programmes in environmental skills, ESG fundamentals, resource efficiency and carbon awareness are needed, together with employee engagement in environmental practices. If C4 is weak, the development of flexibility, crisis management, learning ability and cross-cultural communication is required. If C5 is weak, the problem lies not only with employees but also with management, so



change management, strategic communication, manager training, new KPIs and role redesign are required. If C6 is weak, the transformation may provoke resistance, so transparent communication, employee engagement, an explanation of the social logic of change and a just-transition policy are necessary.

The proposed approach is relevant not only for enterprises but also for higher education institutions, in particular faculties of finance and economics that train specialists in management, international management, finance, marketing, public administration and law. For educational programmes, this means that the traditional competencies of a manager should be supplemented with blocks on AI literacy, data literacy, green human resource management, ESG management, digital transformation management, change management, international risk management, human-machine collaboration, and the ethical and legal aspects of AI. This is especially important for international management programmes, since a modern manager works not only with staff and markets but also with international standards, digital tools, ESG requirements, multicultural teams and an unstable external environment.

The scientific novelty of the article lies in improving the theoretical and methodological approach to assessing human capital readiness for the digital and green transformation of organisations by means of the integrated HCR index, which combines a digital component, readiness for AI and automation, and green/ESG, adaptive, managerial, and social and motivational components. Unlike approaches that assess only digital skills, isolated HR practices or readiness indices built on fewer dimensions (Farlis et al., 2025), the proposed integrated index makes it possible to identify a multidimensional gap in readiness for a complex digital-green transformation under conditions of international instability and

post-war reconstruction, and to translate it into targeted managerial actions.

Conclusions. The article has posed and addressed the problem of developing a theoretical and methodological basis for assessing human capital readiness for the digital and green transformation of organisations by means of the integrated HCR index. It has been shown that digital and green transformation are not purely technological or environmental processes: they change the content of work, the structure of competencies, the management system, the socio-psychological climate and the international competitiveness of organisations, and under conditions of international instability these processes are intensified by geopolitical risks, market fragmentation, migration, energy crises and uneven access to skills. The sharpest manifestation of this is the post-war reconstruction of Ukraine, where a simultaneous digital and green transition must take place under conditions of heightened external risk and European-integration requirements.

Analysis of open data from Eurostat, the OECD and the World Economic Forum confirms that the main barrier to transformation is not access to technology but human capital readiness; skills gaps should therefore be regarded as the principal barrier to business transformation, while the green transition requires systematic upskilling and reskilling. The proposed approach combines six key components and allows management not only to determine the overall level of readiness but also to identify specific gaps that require intervention. A system of indicators, a procedure for calculating partial scores with explicit summation indices, an approach to determining weights with a built-in safeguard against the masking effect, and an equal-interval interpretation scale have been developed; applicability has been illustrated for organisations in high-technology and internationally integrated sectors – aviation



and logistics – as reference cases for post-war reconstruction.

Further research may focus on the empirical validation of the integrated index in various sectors – aviation, logistics, small and medium-sized business, public administration and higher education – and on comparing the levels of human capital readiness in organisations with different digital maturity, ESG requirements and degree of international integration, in particular in the context of Ukraine's post-war reconstruction.

Disclosure on the Use of Artificial Intelligence. In preparing this manuscript, the authors used an AI-based assistant for language editing, formatting and structuring bibliographic descriptions, as well as for searching and summarising open analytical sources. All scientific content – the formulation of the problem, the methodology, the construction of the index, the calculations and the interpretation of results – was developed, verified and approved by the authors, who bear full responsibility for the accuracy and integrity of the work. No AI system is listed as an author.

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