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# Human-centric approach to creating sustainable innovation in the context of Industry 5.0

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**ABSTRACT**

**Objective:** The article aims to explore how human-centric organisational practices, combined with employee dynamic capabilities (EDC), can drive sustainable innovation in the Industry 5.0 concept.

**Research Design & Methods:** We conducted an empirical study to verify hypotheses regarding human-centric organisational practices and their impact on sustainable innovation. We conducted a questionnaire-based study among 462 organisations from Poland. We tested research hypotheses with a linear regression analysis with a mediator using the Macro Process for IBM SPSS.

**Findings:** The critical literature review and empirical verification of the proposed hypotheses indicated that human-centric organisational practices influence sustainable innovation through EDC. Organisational employees are not mere resources but dynamic change agents who, supported by appropriate practices, drive innovation among organisations exhibiting characteristics of the Industry 5.0 concept. Human-centric organisational practices enable EDC, allowing organisations to benefit from them because of the strengthened ability to generate sustainable innovations.

**Implications & Recommendations:** Organisations seeking to implement sustainable innovation should adopt a more dynamic and human-centric approach to human resource management, prioritizing practices that enhance EDC such as adaptability, critical thinking, and creativity. The results confirm that achieving sustainability through innovation requires investments that go beyond technology and infrastructure. Future research could focus on different geographical or cultural contexts. Moreover, scholars could analyse in detail specific employee-centric practices and their impact on EDC and sustainable innovation and extend the proposed model to include new concepts.

**Contribution & Value Added:** The study's results extend the resource-based view and the dynamic capabilities framework by demonstrating that human-centric organisational practices are critical in enhancing EDC for fostering innovations among organisations exhibiting characteristics of the Industry 5.0 concept. They also contribute to the sustainable innovation literature by showing that sustainable innovation is not solely a product of top-down initiatives or rely mainly on technological advancements but also critically depends on the dynamic capabilities of employees that are supported by human-centric organisational practices. Leaders pursuing sustainability through innovation should focus on investing in human-centric practices, particularly those related to the enhancement of EDC.

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## INTRODUCTION

In a world of accelerating technological advancement, organisations increasingly seek ways to innovate sustainably while responding to societal expectations. However, the key to unlocking such innovation

lies not only in the technological advancements themselves – such as AI, cloud, or renewables – but also in how organisations empower their people. Therefore, this paper focuses on the role of human-centric organisational practices (HOCP) in triggering employee dynamic capabilities (EDC), which in turn enhance the organisation's capacity for sustainable innovation (SI).

Although scholars have given much attention to emerging technologies and industrial paradigms like Industry 5.0, the literature places less emphasis on the mechanisms through which organisations can enable their human potential to drive innovation that is both socially and ecologically responsible. Such innovation, called sustainable innovation, is increasingly in demand among consumers who, besides expecting fast-paced change, are also aware of the broader impact of the products and services they choose (Ansu-Mensah, 2021; Zeynalova & Namazova, 2022; Lubowiecki-Vikuk *et al.*, 2021; de Sousa, 2023). As noted by Trendwatching (2024), sustainability is one of the prominent characteristics in current consumer trends, reflecting a deeper societal shift in expectations. Therefore, the question should concern not only whether organisations can meet sustainability goals through technological advancements, but whether they can foster internal conditions that allow their employees to contribute meaningfully to those goals. The article considers human-centric organisational practices that place employees at the centre of strategic and operational decisions, as the trigger of EDC, allowing employees to adapt, innovate, and align with evolving organisational needs. This dynamic capability becomes critical in turbulent environments, where responsiveness and resilience are strategic imperatives. Although Industry 5.0 provides a useful context for framing human-centricity, sustainability, and resilience as organisational priorities (Breque *et al.*, 2021), this study does not focus solely on this paradigm. Rather, it seeks to contribute to a broader discussion on how internal human-oriented strategies can catalyse innovation outcomes aligned with sustainability and long-term competitiveness. As Acemoglu and Johnson (2023) emphasize the need for external regulation to ensure inclusive innovation, this article highlights the complementary role of internal managerial support and leadership.

This study aims to fill a gap in the literature by examining the mediating role of EDC in the relationship between human-centric organisational practices and sustainable innovation, a relationship yet to be fully explored, particularly in dynamic and innovation-intensive environments, such as Industry 5.0. Furthermore, by incorporating the dynamic capabilities framework (Teece *et al.*, 1997; Bieńkowska & Tworek, 2020) into the resource-based view (RBV) (Wernerfelt, 1984; Barney, 1991), the research connects traditional resource-focused approaches to innovation with contemporary human-centred organisational strategies. To fulfil such aim, we performed the critical literature review to establish theoretical hypotheses and next, we conducted empirical research to verify them in the context of organisations developing into the Industry 5.0 framework.

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

### Sustainable Innovation

The debate on how to combine economic, environmental and social benefits while aiming for sustainable development has intensified over the last two decades (Boons & Lüdeke-Freund, 2013; Leal Filho *et al.*, 2022). This has increased the pressure on organisations to respond intensively to the challenges of climate change, environmental degradation, and social inequalities by embedding the concept of sustainability into their business practice (Hermundsdottir & Aspelund, 2021; Cataldo *et al.,* 2024; Adams *et al.*, 2016). Moreover, regulatory changes and increasing customer and stakeholder demands have driven the need to conduct sustainable actions, accompanied by proper monitoring and reporting of their outcomes (Provasnek *et al*., 2017; Xie *et al*., 2019). Nowadays, the pressure to comply with existing regulations is believed to be the key driver for organisations to move towards sustainability, especially if the target markets include European Union member states (Chan *et al*., 2016).

Sustainable innovation is a generalised term for sustainable business development, responding to social and environmental concerns. Combining the concepts of sustainability and innovation offers a meaningful approach to a new paradigm, where innovation is rooted in sustainable development and guided by the principles of ethical, social, economic and environmental responsibility (Cataldo *et al*.,

2024). At the intra-organisational level, the importance of factors such as uncertainty acceptance, social awareness, environmental competence, (Longoni & Cagliano, 2018), and leadership or knowledge management strategies (Adams *et al.*, 2016) is highlighted for sustainable innovation.

In the literature, scholars often use the term 'sustainable innovation' interchangeably with 'eco-innovation' (Boons & Lüdeke-Freund, 2013), 'green innovation,' 'environmental innovation' (Ben Arfi *et al*., 2018; Hojnik & Ruzzier, 2016), despite the slight differences between these issues. However, the general trend demonstrates that there is already a consensus around the three-dimensional view on both the process and the result with an emphasis on the overall human well-being. Tello and Yoon (2008), state that 'sustainable innovation in a broad sense is defined as any improvement in the quality of products, services, and technologies that benefit a firm and institutionally improve human well-being at large.' In contrast, Clark and Charter (2007) define it as 'a process where sustainability considerations (environmental, social, and financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialization.' In this article, the authors will focus on three dimensions of sustainable innovation: economics, environmental, and social.

**Economic Dimension of Sustainable Innovation**

Since the Schumpeterian approach to innovation, which identified innovation as the main driver of economic development, innovation has become a central economic term, affecting organisations, sectors, and societies. For a long time, sustainability innovation has been perceived as a cost factor for the organisation (Hermundsdottir & Aspelund, 2021; Adams *et al.*, 2016), initially requiring significant investments, a long payback time, and no guarantee of social or environmental benefits (Hermundsdottir & Aspelund, 2021; Hojnik & Ruzzier, 2016). However, from an economic perspective, sustainable innovation is crucial to support long-term growth and sustainability (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013), as well as to achieve sustainable competitive advantage (Christmann, 2000; Caracuel, de Mandojana, 2013; Hermundsdottir & Aspelund, 2021). Sustainable innovation often leads to significant savings and performance improvements, *e.g.* by adopting energy-efficient technologies in the industry, organisations reduce energy consumption and lower operating costs (Christmann, 2000; Aguilera-Caracuel & Ortiz-de-Mandojana, 2013). Moreover, the shift toward sustainability opens new markets causing an increase in demand from consumers focused on ecology and environmental protection (Christmann, 2000; Aguilera-Caracuel & Ortiz-de-Mandojana, 2013).

**The environmental Dimension of Sustainable Innovation**

In its environmental dimension, sustainable innovation involves the introduction of a new or significantly improved product, service, production process, management approach, or marketing solution that minimizes environmental impact. This includes reducing pollution, conserving natural resources, and lowering the overall environmental footprint (Carrillo-Hermosilla *et al.,* 2009; Kemp, 2010). Environmentally sustainable innovation can imply reducing greenhouse gas emissions by using solar, wind, and bioenergy (Ramus, 2001; Chaudhry *et al*., 2022), resource efficiency and waste management, *e.g.*, through a circular economy model, and biodiversity conservation, through, *e.g.,* precision agriculture or agroecology (Adams *et al*., 2016; Zhang *et al*., 2019). Sustainable innovation is an integral part of solving environmental problems, by increasing resource efficiency and promoting environmental sustainability (Abbas & Sağsan, 2019) throughout the product life cycle. They are now considered, as one of the most important factors affecting the image and reputation of companies (Gallardo-Vázquez *et al.*, 2019), as well as its competitive position (Abbas & Sağsan, 2019). However, organisations will only invest in activities that will impact their bottom line (Zhang *et al*., 2019), so it is important that these are in line with the long-term goals of the organisation. For this reason, environmental legislation is also important and leads to improved environmental performance in terms of innovation (Kagan *et al.*, 2003; Chan *et al*., 2016).

**The Social Dimension of Sustainable Innovation**

The social dimension of sustainable innovation focuses on improving quality of life, bridging inequalities, and addressing social exclusion. Sustainable innovations respond to social challenges and contribute to the overall well-being of a community or individual (Hölsgens *et al.*, 2018; Leal Filho *et al.*, 2022). The

implementation of sustainable innovations enables the collaboration of various actors – private, public, social organisations or households – allowing them to align and act on each other's interests (Beers & Geerling-Eiff, 2014). Sustainable innovation in the social dimension also encompasses practices such as employing people at risk of social exclusion, improving workers' living and working conditions (*i.e.*, work-life balance, health protection, and occupational safety), promoting professional development, maintaining, and improving living standards, supporting social causes, and preventing discrimination and human rights violations (Martin-Castejón & Aroca-López, 2016; García-Piqueres & García-Ramo, 2018). Johnson and Acemoglu (2023) highlight the need for a human-centric approach toward innovation. They use the term 'useful machines' to refer to innovations which, in the first place, complement human capabilities and empower people, creating new job opportunities as opposed to simply automating processes and replacing people. Moreover, implementing sustainable innovations can affect an organisation's reputation (García-Piqueres & García-Ramo, 2018), increasing an individual's ability to recruit the most skilful and innovative talents (Guerrero-Villegas *et al.*, 2018; García-Piqueres & García-Ramo, 2018).

Building awareness of sustainability should precede driving sustainable innovation. This will contribute to higher expectations toward sustainable innovations from all the stakeholders enhancing their development and deployment by organisations while transitioning to Industry 5.0.

**Influence of I5.0 Human-centric Practices on Sustainable Innovation I5.0 Human-centric Practices**

The human-centric approach of Industry 5.0 is consistent with the human resource approach, which regards employees as the organisation's key resource, essential for achieving competitive advantage and organisational goals (see Alves *et al.*, 2023). As Saikia (2023) notes, 'Industry 5.0, envisions an industry that is innovative, resilient, socio-centric, and competitive while minimizing negative environmental and social impacts, respecting people, the planet, and prosperity.' Consequently, both approaches view employees as an 'investment,' rather than a 'cost' (Breque *et al*., 2021). Furthermore, the human-centric approach in Industry 5.0 'needs to consider societal constraints, aiming not to leave anyone behind. This has several implications, pertaining to a safe and beneficial working environment, the respect of human rights, and the skills requirements for workers (Breque *et al*., 2021).

These assumptions translate into human-centric organisational practices for Industry 5.0 (I5.0 human-centric organisational practices), which refer to solutions adopted in an organisation which, on the one hand, respond to the above-described challenges of the Industry 5.0 concept and, on the other hand, place the human being as the main axis of the organisation's activity as a key factor of organisational success. At the same time, they do not only relate strictly to the field of human resources but also to the organisation as a whole. In particular, they concern intra-organisational practices related to:

- Improvements in working conditions, both in terms of reducing workplace accidents, particularly in contact with high-tech machinery and equipment, and ensuring the mental health of workers (Breque *et al.,* 2021). 'Security is a challenge for Industry 5.0 as it is critical to establish trust in ecosystems' (Adel, 2022, p. 9). These efforts aim to improve overall workplace safety while also considering the role of ethics in Industry 5.0 (Longo *et al.*, 2020), ensuring safety at work, and reducing work-related risks.
- Continuous employee development (providing training and development programmes), particularly in deepening digital competences, to achieve synergies in human-machine collaboration (cf. Breque *et al*., 2021; Grosse *et al.,* 2023; Ivanov, 2022). This aligns with the vision where 'human and machine reconcile and work in perfect symbiosis with one another' (Longo *et al.*, 2020, p. 1). Moreover, enhancing these competencies helps reduce and eliminate risks associated with working environments where humans collaborate with increasingly intelligent machines (cf. Breque *et al*., 2021; Ivanov, 2022).
- Development of soft competences such as: 'skills linked to creative, entrepreneurial, flexible, and open-minded thinking' (Breque *et al.*, 2021, p. 19).

Creation of an inclusive working environment that embraces employee diversity and supports their development; considering the individual approach to employees' needs and expectations, providing programmes to increase sensitivity to diversity, and individualising incentive schemes in a broad sense (Breque *et al*., 2021; Ivanov, 2022; Calzavara *et al.,* 2020) to build employee involvement and proactive

attitude in the work process. As a result of the application of I5.0 human-centric organisational practices, an organisation can achieve its goals corresponding to the assumptions of the Industry 5.0 concept, including, in particular, those related to innovation in a broad sense. However, employee dynamic capabilities play a special role in this process as they allow employees to proactively adapt to changes occurring both within the organisation and in its surroundings.

**I5.0 Human-centric Practices' Role in Shaping EDC**

Both practitioners and management theorists emphasise the significant role of employee dynamic capabilities (EDC) (Bieńkowska & Tworek, 2020) in contemporary organisations (cf. Bieńkowska & Tworek, 2024; Tworek *et al.,* 2023; Al Wali *et al.,* 2023; Wang *et al.,* 2024). It appears that the contemporary theory of the resource-based view (RBV) (Wernerfelt, 1984; Barney, 1991) regarding both the organisation as a whole and its employees is insufficient. Therefore, the dynamic capabilities concept developed by Teece *et al.* (1997) complements the resource approach. It responds to the need for a dynamic view of the resources in response to changes in the organisation's environment. Thys, the dynamic capabilities in relation to the organisation as a whole mean 'the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environment' (Teece *et al.*, 1997). Transferring Teece *et al.'s* (1997) concept to the employee level, one can speak of EDC (Bieńkowska & Tworek, 2020), which are a critical complement to employees' existing qualifications and competencies and enable them to perform their work in accordance with the changing conditions of the work environment in which that work is performed. In this context, EDC mean 'abilities to integrate, build, and reconfigure employees' competencies to address rapidly changing environment, which is directly influencing the performance of tasks in the workplace' (Bieńkowska & Tworek, 2020). As understood here, EDC include four dimensions: 'ability to be sensitive to changes in the environment (the ability to see changes, recognize opportunities and risks potentially affecting the performance of work at the workplace), ability to adapt to changes in the environment (the ability to undertake preventive actions, avoiding the occurrence of problems in the workplace), ability to proactively solve problems arising in the workplace (if they occur), and include innovations in the workplace, as well as the ability for continuous personal development and learning' (Bieńkowska & Tworek, 2020).

Given the critical importance of EDC, it is important to develop them effectively. As in the case of employee qualifications and competences, human resources management practices and other organisational solutions serve to shape the level of EDC (cf. Salvato & Vassolo, 2018; Bingham *et al.*, 2015). Regarding the Industry 5.0 concept, human-centric organisational practices may be a natural and sought-after solution that should influence the level of EDC in an organisation This is due to their alignment with the principle of prioritising people as a core of organisations' goals and activities, as well as their role in creating a safe and beneficial working environment (Breque *et al.,* 2021).

As noted above, human-centric practices primarily promote and prioritise employees' skill development, create training opportunities, especially related to new technologies, and actively consider the impact of digital transitions on employees during strategy development. In particular, the above has an almost obvious impact on the potential ability of employees to proactively solve problems arising in the workplace – EDC component. That is because an update in terms of knowledge and skills regarding job requirements, including digital competences, is essential to fully exploit the synergistic effect of human-machine collaboration (Grosse *et al.,* 2023) while mitigating job-related risks. Moreover, a proactive attitude of employees toward solving problems arising in the workplace is fostered by creating a workplace that is safe (in the sense of preventing workplace accidents and ensuring mental health) and that respects the human rights of the employee. In such a workplace the efforts to jointly achieve organisational goals are valued and mistakes are not seen as a reason to punish employees, but as an inspiration for continuous improvement, all while prioritizing the well-being of employees. Furthermore, the promotion of employee skill development arises from the necessity of continuous improvement in response to the changing environment. Therefore, the human-centric approach emphasises the creation of opportunities for continuous employee development (Giniuniene & Jurksiene, 2015; Schilke *et al.,* 2018, Ingram, 2019; Al Wali *et al*., 2023), which is critical in the EDC concept.

Moreover, the human-centric promotion of diversity as an element of workforce strategy (also reflected in the areas of hiring and promotions) sensitizes employees to the changing and diverse needs of both the organisation and its business environment, which in turn enables the employee to recognize changes, identify opportunities and risks potentially affecting the performance at the workplace, which is also an important component of the EDC. Furthermore, a human-centric approach aims to leave no one behind, meaning that the actions taken within the organisation affect all its employees and are not limited to certain groups, *e.g.*, the best or most committed employees. Inclusiveness has a positive impact on raising dynamic capabilities in the organisation (cf. Salvato & Vassolo, 2018). Therefore, it is possible to underline the systemic impact of human-centric organisational practices on the individual components of EDC, with the simultaneous assumption of reaching every employee in the organisation. In this context, we hypothesised:

**H1:** Human-centric organisational practices have a positive influence on EDC.

**The role of EDC in Shaping Sustainable Innovation**

Employee dynamic capabilities encompass innovative thinking and idea generation on behalf of the employees, thereby enhancing innovation development and deployment. The core question is whether EDC can foster sustainable innovation. When applied to sustainable innovation, EDC should enable the organisation and its employees to not only respond to the vulnerability of the environment with new products, services or operational processes, but also ensure that these innovations simultaneously create economic, social, and environmental benefits, generating shared impact beyond mere shareholder value.

A proactive attitude in employees, considering the needs central to the concept of Industry 5.0, is critical for the effective development and implementation of innovations in modern organisations. Sensitivity to changes occurring in the environment draws attention to emerging or anticipated needs, which are a determinant of development, and which set the direction of innovative changes. Employees with dynamic capabilities are adept at identifying emerging trends and opportunities related to sustainability. According to Abcouwer and Takacs (2020), in a vulnerable environment with an unpredictable future, organisations require flexibility and adaptive capabilities of their employees to achieve a person/future fit to succeed in innovations. Such employees can anticipate market shifts and regulatory changes, positioning the organisation to innovate sustainably. This aligns with the growing consumer demand for sustainable products and services, as highlighted by recent research (Ansu-Mensah, 2021; Zeynalova & Namazova, 2022).

Once opportunities are identified, employees can mobilize resources and align organisational processes to seize these opportunities. This involves developing new products or services that meet sustainability criteria, optimizing existing processes to reduce environmental impact, and leveraging advanced technologies to enhance efficiency and reduce waste. Sustainable innovation often requires significant changes in organisational structures and processes. Employees with dynamic capabilities can lead these transformations, ensuring that the organisation not only adapts to sustainable practices but also embeds them into its core operations. This transformation is essential for maintaining a competitive advantage in a market increasingly focused on sustainability (Lubowiecki-Vikuk *et al.,* 2021). Moreover, employees with well-developed EDC can identify risks related to digital process innovations and job loss, anticipating the potential social tension in the community. Such employees are then capable of introducing labour-friendly solutions.

However, to a large extent require, sustainability initiatives specialised knowledge and expertise. The rapidly evolving technologies to address upcoming issues, such as automation and eco-efficiency solutions, necessitate another dynamic capability, *i.e.*, continuous learning. Continuous personal development and learning are prerequisites for having the ability to develop innovative solutions based on the latest scientific achievements. Thus, companies invest in training programs for their leaders and employees permanently to facilitate sustainability decisions at large scales (Polman & Bhattacharya, 2016). Outperforming companies have employees with skills and functional expertise focused on customers and the external ecosystem, who can demonstrate quick reaction to change and realize value

very quickly within the innovation and transformation processes (Bohlin *et al.*, 2023).

Based on the above, we hypothesised:

**H2:** EDC have a positive influence on sustainable innovation.

### I5.0 Human-centric Organisational Practices' Influence on Sustainable Innovation Through EDC

Advocates of Industry 5.0 note that Industry 4.0, focused on productivity and technology, is not the right structure to achieve sustainability goals and sustainable innovation. It is Industry 5.0, representing a paradigm in which workers play a central role in cyber-physical systems (Grabowska *et al.,* 2022) that emphasizes the importance of synergy between humans and machines (Grosse *et al.*, 2023; Özdemir & Hekim, 2018; Grabowska *et al.,* 2022). According to Horvat *et al.* (2024), 'this synergy leads to more robust ideation processes, enhancing both explorative and exploitative knowledge capabilities, which are crucial for generating innovative solutions to complex problems.' The synergy between competent employees and advanced technologies will be key to bearing the innovative capacity of companies (Adel 2022; Mikalef *et al*., 2020), through the active involvement of employees in the innovation process (Weigt-Rohrbeck & Linneberg, 2019; Horvat *et al.,* 2024), their enhanced capabilities related to knowledge creation and analysis (Horvat *et al.*, 2024), a proactive approach (Weigt-Rohrbeck & Linneberg, 2019), and an attitude that fosters creativity and exploratory thinking (Park *et al.*, 2014). Competent workers are a valuable resource for solving complex challenges in sustainability-oriented innovation (Hector & Cameron, 2023). They understand the environmental and social challenges and can therefore implement innovations in line with sustainability goals by means of modern technological solutions, *e.g.*, giving them the ability to process huge amounts of data (Ramus, 2001; Weigt-Rohrbeck & Linneberg, 2019).

Sustainable innovation often lies beyond the scope of employees' operational activities. According to Weigt-Rohrbeck and Linneberg (2019), 'employees who are satisfied with their allocated tasks will be more likely to take on additional tasks.' Therefore, human-centric practices leading to higher job satisfaction enforce sustainable innovation in the organisation. Job satisfaction and employee engagement will depend on the right work environment, in which talent and diversity management, employee experience, and organisational culture based on trust, inclusion and collaboration are important (Ramus, 2001; Hector & Cameron, 2023; Ingram, 2019). As a result, without diminishing the role of technology for economic growth and value creation, Industry 5.0 provides a framework for integrating economic and social goals through workplace safety and optimal human-machine relations in the work environment and social and environmental responsibility – in the outside surroundings (Gorodetsky *et al.,* 2019; Ivanov, 2022).

Hence, we hypothesised:

**H3:** Human-centric organisational practices have a positive influence on sustainable innovations.

Human-centric organisational practices, through the construction of an appropriate work environment, are a key element in the development of EDC (Nold, 2019; Hector & Cameron, 2023). Recent research indicates that innovation is, as it were, a consequence of EDC (Giniuniene & Jurksiene, 2015; Schilke *et al.,* 2018; Ingram, 2019; Al Wali *et al.,* 2023), which contributes to an organisation's innovation capacity (Al Wali *et al.,* 2023). Supported by human-centric management and favourable working conditions, EDC facilitate an organisation's recognition of potential technological change but also strengthen its ability to adapt to change through innovation (Hill & Rothaermel, 2003; Mousavi *et al.,* 2018). EDC facilitate managers' ability to effectively perceive changes in the internal and external environment of the organisation and enhance the ability to purposefully combine, allocate and develop internal and external resources, contributing to the long-term success of the organisation (Mousavi *et al.,* 2019; Mishra *et al.,* 2022). The mediating role of EDC in implementing sustainable innovation is highlighted by Mousavi *et al.* (2018), who are optimistic about the potential of EDC in shaping a deeper understanding of sustainability innovation management. According to Longoni *et al.* (2014), the conceptualisation of employees and dynamic capabilities are linked to social and environmental sustainability outcomes.

Given the above considerations, we posed a complementary hypothesis:

**H3m:** Human-centric organisational practices positively influence sustainable innovations through EDC.

Hence, the proposed hypotheses form a model presented in Figure 1.

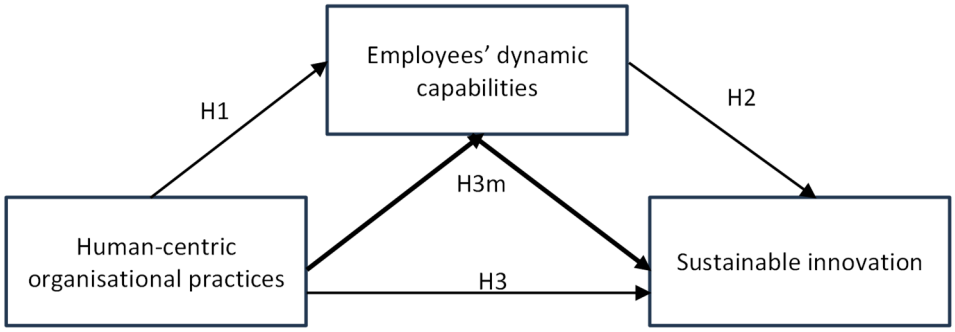


**Figure 1. Model of hypotheses**
Source: own elaboration.

## RESEARCH METHODOLOGY

We applied a two-phase empirical study to validate the theoretical framework and examine and confirm hypotheses concerning human-centric organisational practices and their effects on sustainable innovation. Initially, we conducted a pilot study to validate the measurement tool, followed by the main research phase. To collect primary data, we used a questionnaire, which included newly developed measurement scales along with previously validated scales for various model variables and control variables.

Top-level managers from Polish organisations completed this questionnaire. Each provided a single response per organisation due to their thorough understanding of organisational operations. The pilot study aimed to assess the questionnaire quality, including all proposed measurement scales, and involved 25 purposefully selected senior managers acting as judges. Their feedback helped refine several questions to ensure they were clear and understandable. The main research phase, conducted in the first quarter of 2024, focused on analysing and verifying the proposed hypotheses. We conducted it using the computer-assisted web interview (CAWI) method, based on a purposively selected and bought respondents panel consisting of top-level managers employed in organisations in Poland, which exhibited some characteristics from the Industry 5.0 concept. We obtained 462 fully filled-in questionnaires and included them in the sample for this study. Table 1 shows the characteristics of the sample, which includes a diverse mix of organisations, differing in case of size, industry, and technological advancement. While the sample was not representative, the diversity of the participating organisations supports meaningful conclusions. Including various sectors strengthens the findings' robustness. Moreover, we calculated the Kaiser-Meyer-Olkin (KMO for each variable and model to confirm that the sample size and diversity were adequate for the planned statistical analyses.

**Table 1. Sample description: Organisation size**

| Size of employment | Number of organisations |
|---|---|
| Less than 10 people | 15.32%; 70 |
| 10 and more people, but less than 50 people | 23.19%; 106 |
| 50 and more people, but less than 250 | 32.60%; 149 |
| 250 and more | 28.88%; 132 |
| Total | 457 |

Source: own study.

### Variables

To verify the formulated hypotheses, we utilized the following variables:
**Human-centric organisational practices (HCOP)** underwent assessment using six items related to employee support initiatives.

**Employee dynamic capabilities (EDC)** included eight items across four dimensions: sensitivity to changes, ability to adapt to those changes, capacity to solve problems and innovate within the workplace, and potential for continuous personal development (Bieńkowska & Tworek, 2020).
**Sustainable innovation (Sinn)** variable was based on 13 items concerning economic, environmental, and social aspects of sustainable innovation.

We evaluated all items in the above variables on a 5-point Likert scale.

We constructed the questionnaire in SurveyMonkey in English. It consisted of several sections concerning questions about various aspects of organisations operations. Appendix A gives specific items for each variable.

To verify the proposed hypotheses, we rigorously analysed and validated all measurement scales, using the IBM SPSS. We confirmed the data's normal distribution, which was followed by three statistical tests to check for the reliability and validity of the measurement scales. Cronbach's alpha analysis assessed the coherence and reliability of the measurement scale. Obtained numbers above 0.7 (for EDC) indicate average reliability, while values above 0.8 (for HCOP and SInn) are more satisfactory (Drost, 2011). We conducted confirmatory factor analysis (CFA) using IBM SPSS. This test verified the coherence and internal consistency of the measurement scale. The average variance extracted (AVE) value should exceed 0.5. We evaluated model fit statistics with the following criteria: $\chi^2/df < 5.000$, TLI > 0.800, CFI > 0.800, GFI > 0.800, and RMSEA < 0.2 (Hopwood & Donnellan, 2010). Kaiser-Meyer-Olkin (KMO) test assessed the adequacy of the sample size. All values accede 0.5 and therefore the size of the sample was sufficient (Field, 2000; Kaiser, 1974).

Table 2 presents the results, showing that the scales were internally consistent, reliable, and coherent, hence, allowing for a robust hypothesis verification. We also utilized the heterotrait-monotrait ratio (HTMT) to assess discriminant validity. The obtained values were below 0.65 (Hamid *et al*., 2017), indicating the variables' suitability for further analyses. The variables were first-order latent variables.

**Table 2. Variables overview**

| Variable | Number of items | AVE | K-M-O | Cronbach's alpha | N |
|---|---|---|---|---|---|
| HCOP | 6 | 0.523 | 0.856 | 0.822 | 455 |
| EDC | 5 | 0.531 | 0.811 | 0.778 | 452 |
| SInn | 13 | 0.547 | 0.962 | 0.931 | 445 |

Source: own study.

Moreover, we utilized Harman's single-factor test (Aguirre *et al*., 2019) to confirm the absence of the common method bias, as we used the same questionnaire to collect all the primary data. Through IBM SPSS and the dimension reduction procedure, we checked if any of the factors explained more than 50% of the variance among variables, which would indicate bias. The confirmatory factor analysis, with factors fixed at one, revealed that the single factor explained only 32.0% of the variance. This indicates that the sample did not have a common method bias. Moreover, we undertook various steps at the time of survey development to limit common methods bias: (1) we separated items measuring independent and dependent variables in the questionnaire, (2) we used different formats and sometimes different scales for each variable, (3) we avoided ambiguous, vague, or complex questions were avoided.

## RESULTS AND DISCUSSION

### Research Results

We used a linear regression analysis incorporating a mediator, run in Process Macro for IBM SPSS to examine the formulated hypotheses. As outlined by Saks (2006), three conditions must be met to establish mediation. Firstly, there must be a significant association between independent variables and mediators. Secondly, the mediator must exhibit a significant relationship with the dependent variables. Thirdly, when the mediator is accounted for, the effect of the independent variables on the dependent variables should either diminish (indicating a partial mediation) or disappear (indicating full mediation).

To verify the first two criteria, we conducted Pearson's correlation analysis using IBM SPSS. The findings, presented in Table 3 support the fulfilment of these conditions. There were statistically significant and strong correlations among all the analysed variables and the strongest correlation appeared between human-centric organisational practices and EDC (r = 0.732).

**Table 3. Results of correlation analysis**

| Variable | | HCOP | EDC | Sinn |
|---|---|---|---|---|
| HCOP | r-Pearson | 1 | – | – |
| | p | – | – | – |
| EDC | r-Pearson | 0.732 | 1 | – |
| | p | <0.001 | – | – |
| SInn | r-Pearson | 0.376 | 0.366 | 1 |
| | p | <0.001 | <0.001 | – |

Source: own study.

Such findings provide a basis for proceeding with hypothesis testing related to EDC through a mediated linear regression analysis. We developed a mediation model, positioning human-centric organisational practices as the independent variable and sustainable innovation as the dependent variable, with EDC serving as the mediator. For the regression model to be valid, it must demonstrate statistical significance, and the total effect must exceed the direct effect observed between the variables. Table 4 summarises the outcomes of this analysis.

**Table 4. Results of mediation analysis**

| Mediator | Direct effect value | Indirect effect value | Boot LLCI | Boot ULCI | R2 |
|---|---|---|---|---|---|
| EDC | 0.4046 | 0.2512 | 0.0784 | 0.4282 | 0.541 |

Source: own study.

The results of the mediated linear regression analysis indicate that the model is statistically significant (F (1.439) = 517.548, p<0.001 and corrected R2= 0.464). The overall fit of the model is more than satisfactory for the social science empirical research, as R2 = 0.541, which shows that a significant portion of dependent variable variance is explained by the independent variable and mediator. Furthermore, we confirmed EDC to be a statistically significant mediator within the model (p<0.001, coeff. = 0.3442, se = 0.1130). The mediating effect is also statistically significant, as we conclude from Table 4, as it shows that there is an indirect effect within the given model, and both Boot LLCI and ULCI remain above 0, which renders the results statistically significant. Since the model includes both direct and indirect effects, this supports the presence of partial mediation. These findings support the acceptance of both hypotheses, demonstrating that human-centric organisational practices have a positive impact on sustainable innovation, with EDC mediating this relationship.

## Discussion

This study offers significant contributions to the growing body of literature on sustainable innovation, dynamic capabilities, and the emerging paradigm of Industry 5.0 by empirically demonstrating the mediating role of EDC in the relationship between human-centric organisational practices and sustainable innovation. Building on the resource-based view (RBV) concept and extending it with the dynamic capabilities (DC) framework, our study enables a broader theoretical understanding of several key research areas. Traditionally, the RBV has focused on the static resources available to organisations, without focusing on the opportunities to develop such resources, whereas the dynamic capabilities framework, proposed by Teece, Pisano, and Shuen (1997), emphasizes the adaptive nature of an organisation's ability to integrate, build, and reconfigure internal and external competencies in response to environmental change.

Firstly, our findings contribute to the development of theory on Industry 5.0 by confirming that its human-centric pillar is not merely philosophical or ideological, but can indeed be operationalized in terms of specific organisational practices that influence innovation outcomes. While the Industry 4.0 literature has emphasized the importance of automation and productivity growth, this study shows

that human-centred organisational design – centred on employee well-being, development, inclusion, and safety – creates the right environment to support EDC, but also actively unlocks these dynamic capabilities. This activation of employee potential is key to generating sustainable innovation that is aligned with economic, environmental, and social goals, and that leads to sustainable development in the long term. To remain competitive and responsible in the era of Industry 5.0, organisations must adopt a holistic, human-centric approach that promotes a culture of adaptation, continuous learning and proactive problem-solving. This is underlined by the results of the study, which indicate the need to change traditional innovation strategies based on technology or costs.

Secondly, the study responds to calls for more empirically grounded research on how employee-level capabilities drive innovation in turbulent, technologically advanced environments. The study provides robust evidence that EDC are a central mechanism through which human-centric practices translate into innovation outcomes. This is especially important in contexts aligned with Industry 5.0, where innovation must deliver shared value for multiple stakeholders, including employees, communities, and the environment. The results provide a more nuanced understanding of how organisational practices influence sustainability outcomes. Previous research has often focused on the direct effects of organisational culture or leadership on sustainable innovation (Boons & Lüdeke-Freund, 2013; Hermundsdottir & Aspelund, 2021). However, this study adds to this by illustrating the mediating role of EDC in this relationship. It suggests that sustainable innovation is not solely a product of top-down initiatives but also depends critically on the dynamic capabilities of employees – capabilities that are unlocked and nurtured within an environment intentionally designed by human-centric organisational practices. Moreover, EDC enable the organisation to identify and capitalize on new opportunities related to sustainability-oriented innovation, which in turn are essential to maintaining a competitive edge amid growing pressure for sustainability. Human-centric orientation in an organisation will also be important in creating sustainable business models or finding new ways to implement eco-innovation. The involvement of employees in organisational processes and their high creativity allows organisations to respond flexibly and adaptively to changing market conditions, resulting in higher efficiency of innovations introduced. This finding bridges the gap between high-level strategic initiatives and individual employee behaviours, highlighting the importance of aligning organisational practices with employee development to achieve sustainability goals.

Thirdly, the research contributes to the sustainable innovation literature by reinforcing that such innovation is not merely a function of technological investment or leadership commitment. Instead, the ability to generate sustainable outcomes lies in the distributed, bottom-up capabilities of employees, who can sense, adapt, and respond proactively to changing needs. This people-centred perspective shifts the focus of innovation from being solely a top-down strategic imperative to an organisation-wide competency, nurtured by supportive practices that trigger and develop EDC.

The results of this study also provide several practical implications for business leaders, policy-makers, and organisational designers who want to align their organisations with Industry 5.0 principles and deliver on sustainability targets through sustainable innovation. The first is the need for strategic investments in human-centred practices. Organisations striving for sustainable innovation should prioritise policies that improve employee experience, safety, well-being, and inclusion. These should not be mere ethical or compliance measures but should be viewed as strategic enablers of innovation through the development and activation of EDC. Human-centred practices create an environment for the development of dynamic employee competencies. The second one concerns human resources as a driver of innovation. The findings underscore the critical role of fostering a dynamic workforce, one that continuously learns, adapts, and contributes creatively. HR departments should evolve from administrative units into strategic partners in innovation by designing systems that promote agility, resilience, and employee-led problem-solving to enhance their EDC. The third one is linked to reframing technology implementation. As organisations adopt new technologies (for example AI, IoT, and robotics), the focus should be on complementing human capabilities rather than replacing them to establish an environment conducive to innovativeness. This shift requires the development of human-machine collaboration skills, which human-centric practices can effectively cultivate. Finally, there are also policy and organisation-level considerations. The study reinforces the value of incentivizing human-centric

innovation practices, *e.g.*, through subsidies, regulatory frameworks, or recognition schemes that reward organisations demonstrating social and environmental impact via employee-driven innovation.

## CONCLUSIONS

This article aimed to explore how human-centric organisational practices, in conjunction with EDC, can drive sustainable innovation within the framework of Industry 5.0. Industrial transformation increasingly forces organisations to change values, employees and technologies. An extensive literature review provided the basis for the hypothesis that human-centred practices, which are the central point of Industry 5.0, influence sustainable innovation through the development of EDC, but also enable the construction of an environment for the development of EDC. We empirically confirmed the mechanism and the mediation model showed that EDC significantly strengthened the relationship between human-centred organisational practices and sustainable innovation. Therefore, this study contributes to the literature by combining the human-centred approach, which is the operating philosophy of Industry 5.0, with the RBV and dynamic capabilities frameworks, showing that human-centred organisational practices enhance EDC, which in turn drive sustainable innovation.

The study results confirm that the human-centric pillar of Industry 5.0 can be effectively translated into organisational practices that support the dynamic employee capabilities necessary to drive sustainable innovation across economic, environmental, and social dimensions. Through robust empirical analysis on a diverse sample of Polish organisations, it demonstrates that these capabilities serve as a key mechanism linking human-centric design to innovation outcomes, especially in rapidly evolving environments. Ultimately, the research reframes sustainable innovation as a distributed, employee-driven process, highlighting the need for inclusive, bottom-up strategies rather than solely top-down initiatives.

The article demonstrates that human-centric organisational practices are not only aligned with Industry 5.0 aspirations but are essential to their implementation. The study empirically confirms that these practices are a direct, powerful driver of sustainable innovation by building an environment for enabling and developing EDC. As organisations move beyond the automation-driven mindset of Industry 4.0, the need for a more inclusive and sustainable approach becomes evident. Hence, from a practical perspective, it shows that fostering human-centric environments that nurture employee adaptability, creativity, and continuous learning, while bearing EDC, is essential for achieving sustainable innovation – economically, socially, and environmentally. It highlights the need for organisations to move beyond traditional innovation strategies that are technology- and cost-driven. A holistic approach that prioritizes human-centric practices is essential to fostering a culture of continuous learning, adaptability, and proactive problem-solving – key components of sustainable innovation that remain at the heart of Industry 5.0. Combining human-centric Industry 5.0 practices with sustainable innovation by exploring the intermediary role of EDC allows for the practical operationalization of organisational activities and the strengthening of the employee's role as an innovator.

While this study provides valuable insights into the relationship between human-centric organisational practices, EDC, and sustainable innovation, it is not without its limitations. Firstly, the research was conducted within a specific geographic context, focusing on organisations in Poland. Secondly, the study relies on self-reported data collected through questionnaires completed by top-level managers. While this approach ensures that respondents have a thorough understanding of organisational operations, it also introduces the potential for response bias. The self-reported data may introduce common method bias and social desirability effects, potentially inflating the observed relationships between variables. While we addressed this through statistical controls (*e.g.*, Harman's single-factor test), the reliance on a single-source, cross-sectional design limits the generalizability of the findings. Future research could address this by incorporating multi-source data (*e.g.*, combining employee and managerial perspectives) or objective performance indicators.

The study has various potential directions for further research. Firstly, studies should involve different geographical and cultural contexts should be used for verification of the suggested model. Secondly, various specific human-centred organisational practices may be considered, offering insight into the ef-

ficiency of each of them. Future studies could, for example, isolate and test the impact of individual human-centric practices – such as inclusive decision-making, safety-enhancing policies, or personalized training programs – on the development of EDC and innovation outcomes. Longitudinal research may allow for identifying the human-centric practices with the highest long-term impact, and the timing and sequence of such an impact on the innovation performance in the Industry 5.0 context. Moreover, the article presents only one of the important issues related to Industry 5.0, *i.e.*, human-centric orientation. We assumed its influence on the creation of sustainable innovations. In subsequent studies, scholars should consider other factors that could potentially influence sustainable innovations. It is also necessary to further explore the direction of further explanation of the mechanism of the influence of the human-centric approach on sustainable innovation, where the mediating elements will be, for example, attitudes towards work, *i.e.*, motivation or employee engagement. Finally, other variables may be considered as factors boosting the confirmed mechanism of influence on sustainable innovation, considering the scale of innovations implemented or the degree of novelty in the market.

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## Appendix:

**Items used for the measurement of each variable included in the study:**

**Human-centric organisation practices**

Our organisation prioritizes skill development.

Our organisation provides training opportunities for employees to adapt to new technologies.

Our organisation actively seeks and values diversity in our workforce.

In our organisation diversity and inclusion are key components of our workforce strategy, reflected in our hiring and promotion practices.

Our organisation has systems in place to ensure that the work environment is safe, inclusive, and conducive to employee growth.

Our organisation actively considers the impact of digital transitions on employees during strategy development.

**Sustainable innovation**

**Economic dimension**

Our organisation has consistently increased expenditure for process innovation over the past five years, providing environmental and social benefits.

Our organisation has consistently developed and commercialized new products over the past five years, providing environmental and social benefits.

In our organisation, innovation contributes to the achievement of the Sustainable Development Goals (SDGs).

In our organisation, we introduced innovations that equally benefit economic performance and social and environmental responsibility.

**Environmental dimension**

In our organisation, we have improved the manufacturing processes over the past five years to reduce the use of raw materials and energy.

In our organisation, we have improved the manufacturing processes over the past five years to reduce the emission of hazardous substances or waste.

In our organisation, we have improved the manufacturing processes over the past five years to reuse and remanufacture components.

Over the past five years, in our organisation, we have redesigned and improved our product to meet environmental criteria or directives.

**Societal dimension**

In our organisation, we have improved the manufacturing processes over the past five years to reduce rates of injury, occupational diseases, and work-related fatalities.

In our organisation, our innovations address the needs of societal well-being.

In our organisation, we introduce innovations that contribute to the local community's prosperity (beyond our business interests).

In our organisation, our business strategies are developed with input from a diverse range of stakeholders, including cooperators, community, environmental groups, and customers.

In our organisation, we actively invest in and develop technologies and processes that enhance circular economy practices within our industry.

**Employees dynamic capabilities**

Employees in our organisation quickly notice and successfully recognize in the environment (both inside and outside of the organisation) opportunities and threats (including early warning signals) that can affect the work they do.

Employees in our organisation adapt effectively to the opportunities and threats appearing in the environment (both inside and outside the organisation). They undertake preventive actions that enable them to conduct the tasks entrusted to them despite changes in the environment.

Employees in our organisation quickly notice and successfully recognize problems appearing at the workplace.

Employees in our organisation quickly solve problems; they do it on their own or seek support (within the scope of knowledge and information) that allows them to perform assigned tasks.

Employees in our organisation generate innovative ideas and original solutions to problems.

## Authors

The contribution share of authors is equal and amounted to 25% for each of them. AB, KT – conceptualisation and methodology, KT – calculations, AB, KT, OV, JZ – manuscript writing, discussion, and conclusion.

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## Use of Artificial Intelligence

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## Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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