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Leadership 5.0

New leadership style for Industry 5.0

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Introduction

Approaching the new Industry 5.0 era, organizations must not only adapt to the rapid technological advancements but also contend with the evolving dynamics of human-centric values, sustainability and resilience. Organizations committing to the change, need to adopt a new leadership style that can effectively navigate this complex and dynamic environment. The study of organizational leadership, defined as the process of influencing people to achieve organizational goals, remains a popular and evolving field. This enduring interest stems from leadership's impact on individuals, teams, and entire organizations, underscoring the need for deeper exploration, especially in case of impact on organizational performance, particularly in the context of transforming organizations to thrive in the face of constant change (Dumas and Beinecke, 2018). Renewed focus on leadership also aligns with modern trends in management, particularly situational and contingency approaches (Otley, 1980; Fiedler, 2015). These concepts emphasize the need for leadership styles that adapt to both organizational and environmental contexts (Fiedler, 1967; Hersey and Blanchard, 1969; Kerr et al., 1974; Elkins and Keller, 2003; DuBrin, 2004; Bass and Riggio, 2006).

In the face of rapid technological advancements and evolving organizational environments, leadership is a critical component for organizational success. Effective leadership can enable organizations to adapt and respond to changes in their external and internal environments more proactively (Daniels, 2018). Empirical evidence suggests that effective leadership varies according to circumstances (Bass and Riggio, 2006; Northouse, 2021), including factors related to employees and the organization's internal and external environment. Blanchard (2007) highlights how internal organizational conditions shape leadership, contributing to goal achievement. A prime example of leadership adapting to such specific contexts is the SLII® Situational Leadership Model (Blanchard et al., 1985), a refined version of Hersey and Blanchard's (1969) original situational leadership model. This model matches leadership style with employee development levels to optimize outcomes. Also, various leadership styles have

emerged, tailored to specific sectors. For instance, educational leadership focused on schools (Spillane, 2004; Dorczak and Hesse-Gaweda, 2016), academic leadership on universities (Hazubska, 2023), military leadership on defense organizations (Wong et al., 2003; Kirchner and Akdere, 2017), and medical leadership on healthcare settings (Clay-Williams et al., 2017). These styles reflect the unique characteristics of their respective environments, shaping how leaders influence their teams.

In the framework of the contingency theory of leadership (Fiedler, 2015), the issue of leadership for Industry 5.0 (hereinafter referred to as Leadership 5.0) will be examined. It is assumed that the primary factor shaping leadership is the organizational goal, as defined by the principles of the Industry 5.0 concept. Accordingly, organizations focused on achieving the goals of the Industry 5.0 concept must also adapt their leadership style to support this objective. This involves emphasizing certain elements of leadership that are critical to reaching the strategic goal, ensuring that leadership practices align with and drive the organization's commitment to Industry 5.0 initiatives.

The main principles of the Industry 5.0 concept include integration of advanced technological capabilities with human centric values to create resilient and sustainable (socially and environmentally responsible, reliable) organizations. Key elements of the Industry 5.0 include human-centricity, sustainability, and resilience (Breque et al., 2021). The assumptions of Leadership 5.0 have not yet been defined, although the literature emphasizes the need for leadership styles tailored to organizations, prioritizing innovations for human-centricity, sustainability, and resilience. Hence, Leadership 5.0 may be defined as leadership style that integrates individual traits of the leaders, their behavior toward employees and their behavior toward the organization, with the aim of harmonizing technological progress with the well-being of employees and society. This study will describe the concept of Leadership 5.0 to address the identified research gap regarding the incorporation of Industry 5.0 principles into the field of leadership.

In this context, the main aim of the monograph is to identify, define and validate Leadership 5.0 as a synthetic construct, dedicated to organizations operating under the assumptions of the Industry 5.0 concept. To achieve this aim, an extensive critical literature review was conducted, to identify the factors shaping the concept of Leadership 5.0 and to provide its definition. Subsequently, empirical research was carried out to verify the proposed assumptions.

Despite the growing interest in Industry 5.0 and the emphasis on human-centric and sustainable innovations, there also remains a notable gap in the literature ad-

addressing how leadership influences organizational outcomes within this paradigm. Current research has largely focused on the technological and operational aspects of Industry 5.0, with less attention to the leadership qualities itself and even less attention concerning practices that can shape outcomes such as organizational resilience, employee well-being, and sustainable growth (Yang et al., 2024). Analysis of such influence is essential because, in a rapidly evolving environment, the role of leaders extends beyond traditional management, and they are tasked with integrating advanced technologies in ways that prioritize human and environmental welfare to shape and increase organizational performance, limiting various errors on their way (Joseph et al., 2023). Understanding how Leadership 5.0 can drive these outcomes will fill a significant gap in Industry 5.0 research and provide actionable insights necessary to build adaptive, reliable, and socially responsible organizations amidst technological transformation. Given the above considerations, it is essential to examine how Leadership 5.0 ensures organizational reliability – an outcome variable broader than organizational performance itself – by fostering appropriate processes and culture. This is particularly crucial within the framework of Industry 5.0, which emphasizes sustainable innovation and human-centricity.

Therefore, the second aim of the monograph is to identify the mechanism through which Leadership 5.0 influences organizational reliability and to develop a Leadership 5.0-based model of organizational reliability.

Determining the mechanism by which leadership, dedicated to organizations implementing Industry 5.0 principles, affects organizational reliability should also take into account the dynamic environment in which modern organizations operate. It appears that this perspective requires further expansion, which constitutes another research gap. Hence, another model should consider the use of the dynamic approach toward the issue in question, which would refer directly to the potential for change within the organization, especially in the context of changes occurring in its environment.

Emphasizing the selection of factors influenced by Leadership 5.0 is crucial, especially when these factors are examined from a dynamic and evolving point of view.

Among them, there are: employee dynamic capabilities (EDCs) and IT adaptability. EDCs and IT adaptability refer to a dynamic view of the two most essential resources in the Industry 5.0 concept, i.e., the interaction of people and technology (here: IT) in achieving the organization's overall goals. Employees in the Industry 5.0 concept should be empowered in their industrial work and attracted to work in new high-tech environments. Strengthened by the application of the Leadership 5.0 con-

cept, the EDCs and IT adaptability thus determine reliable human-machine collaboration within an organization. This, in turn, translates into sustainable innovation-friendly entrepreneurial attitudes among employees (Al Wali et al., 2020; Al Wali et al., 2023) and ultimately leads to organizational reliability. Therefore, in organizations adopting a human-centric approach and applying the Leadership 5.0 concept, organizational reliability is shaped dynamically – indirectly through EDCs, IT adaptability, entrepreneurial attitudes of employees, and sustainable innovation – by fostering adaptability to ongoing change and proactive problem – solving.

Accordingly, the aforementioned model describing the static point of view of the phenomenon of the impact of Leadership 5.0 on organizational reliability needs to be supplemented with a dynamic model, that captures an alternative viewpoint. In this context, the third aim of the monograph is to examine the role of factors connected to the potential dynamics of phenomena occurring in the organization, particularly, employees' dynamic capabilities (EDCs) and IT adaptability, as well as intrapreneurship and sustainable innovation, in shaping organizational reliability under Leadership 5.0.

It should be noted here that the choice of organizational reliability as the outcome variable is not accidental. Bieńkowska et al. (2020) defined organizational reliability as the extent to which an organization performs effectively by minimizing errors and maintaining proper functioning under normal and abnormal conditions. It seems that in the framework of Industry 5.0, where the human role in manufacturing systems is emphasized (Prassida and Asfari, 2022; Rahardjo et al., 2024), the issue of mitigating possible errors – especially those generated by humans – takes on particular importance and the analysis of performance itself is not enough (Joseph et al., 2023). Prassida and Asfari (2022, p. 62) stress that with “the crucial role of human workers back to factory floors, I5.0 will bring challenges to the welfare of human workers interacting with the design of smart working systems in an organization”. It should also be mentioned that the literature lacks an explanation of the mechanism of the impact of Leadership 5.0 (or even its partial elements) on organizational reliability. Therefore, the monograph will fill the indicated research gap in management science.

Therefore, to fulfill the aims and address the research gaps, the monograph presents the concept of Leadership 5.0 as a human-centric, sustainable, and technologically adaptive leadership model aligned with the principles of Industry 5.0. It first introduces the theoretical foundations of Leadership 5.0, highlighting leader traits and behaviors towards employees and organizations. The second part explores the relationship between Leadership 5.0 and organizational reliability, analyzed through both static and dynamic approaches, including the roles of trust, creativity, collaboration,

sustainable innovation, dynamic capabilities, IT adaptability, and intrapreneurship. The third part provides empirical verification of the concept, presenting research methodology, measurement scales, and results from multi-stage studies. These include construct validation of Leadership 5.0 and analyses of its influence on organizational reliability in static and dynamic contexts. The monograph concludes with a synthesis of findings, underscoring Leadership 5.0 as a multidimensional construct that strengthens reliability and resilience of organizations in the era of Industry 5.0.

1. The Leadership 5.0 concept

1.1. Industry 5.0 approach

The Industry 5.0 concept, referred to as a “prelude to the sixth industrial revolution” (Di Nardo and Yu, 2021, p. 45), is a response to the challenges arising in the practice of contemporary organizations (Breque, 2021; Grabowska et al., 2022; Di Nardo and Yu, 2021). It considers not only aspects necessary for the Industry 4.0 concept called “techno-economic vision” (Breque et al., 2021, p. 5) or the “technology-driven” concept (Xu et al., 2021, p. 530), i.e., automation of manufacturing processes, digitisation, digitalisation, or data-driven corporate decision-making processes. It also embraces a “value-driven” concept (Xu et al., 2021, p. 530) and goes a step further by placing people and the environment at the center, thereby justifying the organization’s sustainable purpose through their needs. Therefore, rather than focusing exclusively on efficiency gains through digital technologies, Industry 5.0 integrates human creativity and values with advanced technologies to create systems that are not only intelligent but also responsible, adaptive, and inclusive. “Industry 5.0 is understood to recognize the power of industry to achieve societal goals beyond jobs and growth, to become a resilient provider of prosperity, by making production respect the boundaries of our planet and placing the wellbeing of the industry worker at the center of the production process” (Xu et al., 2021, p. 530). In this way, Industry 5.0 “makes industries more future-proof, resilient, sustainable and human-centered” to “better align” and “win-win” the interactions between industry and society, shifting the focus from shareholder value to stakeholder value” (Breque et al., 2021 p. 6). In this context, Industry 5.0 is defined “by a re-found and widened purposefulness, going beyond producing goods and services for profit. This wider purpose constitutes three core elements: human-centricity, sustainability, and resilience” (Breque et al., 2021, p. 13). Thus, Industry 5.0 acknowledges the potential of the industry to go beyond merely creating jobs and economic growth, aiming instead to be a resilient force for societal well-being. It encourages

manufacturing that respects planetary boundaries and prioritizes the well-being of industrial workers at the heart of the production process (Breque et al., 2021).

Industry 5.0 was formally introduced in 2021 by the European Commission, which positioned it as a strategic vision for the future of European industry. It was developed in response to several global challenges:

- Societal pressures, including aging populations, changing labor markets, and increasing inequality.
- Environmental concerns, particularly climate change and the urgent need for sustainable resource use.
- Technological saturation, as Industry 4.0 advanced automation but often overlooked human roles and values.
- Resilience needs, highlighted by crises such as the COVID-19 pandemic, which demonstrated the fragility of global supply chains.

The vision shifts the focus from “technology for efficiency” to “technology with purpose,” embedding innovation within broader societal and environmental goals.

The framework of Industry 5.0 is often summarized in three main pillars (sometimes referred to as “pairs” because they combine human and technological dimensions) (Barata and Kayser, 2023). First one is human-centricity. Industry 5.0 places the human being at the center of industrial systems. Technologies such as AI, robotics, and digital twins are not designed to replace human workers but to complement them, enhancing decision-making, creativity, and well-being. Human-centricity also addresses issues of inclusion, safety, and meaningful work. Second one is sustainability. Unlike Industry 4.0, which focused mainly on efficiency and productivity, Industry 5.0 integrates environmental and social sustainability as key objectives. This involves circular economy models, reduction of carbon footprints, responsible energy consumption, and ethical sourcing. Sustainability ensures that technological advancement supports long-term ecological balance and societal resilience. Third one is resilience (and technological adaptability). It emphasizes the capacity of organizations and systems to adapt and recover in the face of disruptions. Resilience is achieved through diversified supply chains, flexible production systems, and continuous innovation supported by advanced digital technologies. Importantly, resilience also involves technological adaptability – the ability to integrate and evolve with emerging technologies in ways that sustain reliability and long-term competitiveness.

1.2. Premises of the Leadership 5.0 concept

Nowadays, there is no doubt that leadership can be understood either as the characteristics of the leader as a person or as the process of exerting influence (Bieńkowska and Tworek, 2024). Northouse (2021) highlights the importance of individual qualities shaping leadership behavior, emphasizing the need to assess behavior at both individual (employees) and organizational levels. Leadership styles, as outlined by Bieńkowska and Tworek (2024), should combine leaders' traits and the influence process, categorized across three dimensions: individual goals versus collective goals, pro-employee versus anti-employee behavior, and pro-organizational versus anti-organizational behavior.

The industrial revolution's phases have continually reshaped human-technology interactions and induced change, requiring the adaptation of leadership approaches. Industry 4.0's techno-deterministic focus often neglects human values, sustainability, and social fairness, prompting a shift to Industry 5.0. Industry 5.0 emphasizes blending collaborative machine efficiency with human creativity to benefit society and the workforce, demanding leaders who prioritize sustainability, resilience, and human-centric values alongside technological advancements (Adel, 2022; Dcruz et al., 2023).

Leadership 5.0 emerges as a response to these dynamics, integrating leaders' traits, behavior toward employees, and organizational approach to align with Industry 5.0 principles. It aims to foster environments that balance technological progress with societal well-being (Daniels, 2018).

Consequently, the Leadership 5.0 encompass various traits and behaviors that remain in line with crucial aspects of Industry 5.0: human-centricity, sustainability and resilience. Human-centricity prioritizes human creativity, innovation, and problem-solving in industrial processes, enhancing human-machine collaboration and improving welfare. Sustainability focuses on reducing resource consumption, waste, and environmental impact through efficient technologies. Resilience emphasizes adaptable, reliable systems that withstand disruptions and manage risks effectively. The traits and behaviors characterizing Leadership 5.0 have been derived from a thorough understanding of Industry 5.0, as initially outlined in an EU report (Breque, et al., 2021), providing a blueprint for potential leadership characteristics. These characteristics were all attributed to each crucial aspect of Industry 5.0. This framework ensures that leaders not only drive innovation but also prioritize the well-being of individuals and the broader community, adhering to the fundamental principles of sustainability, resilience, and inclusivity advocated in the foundational report (see Figure 1.1).

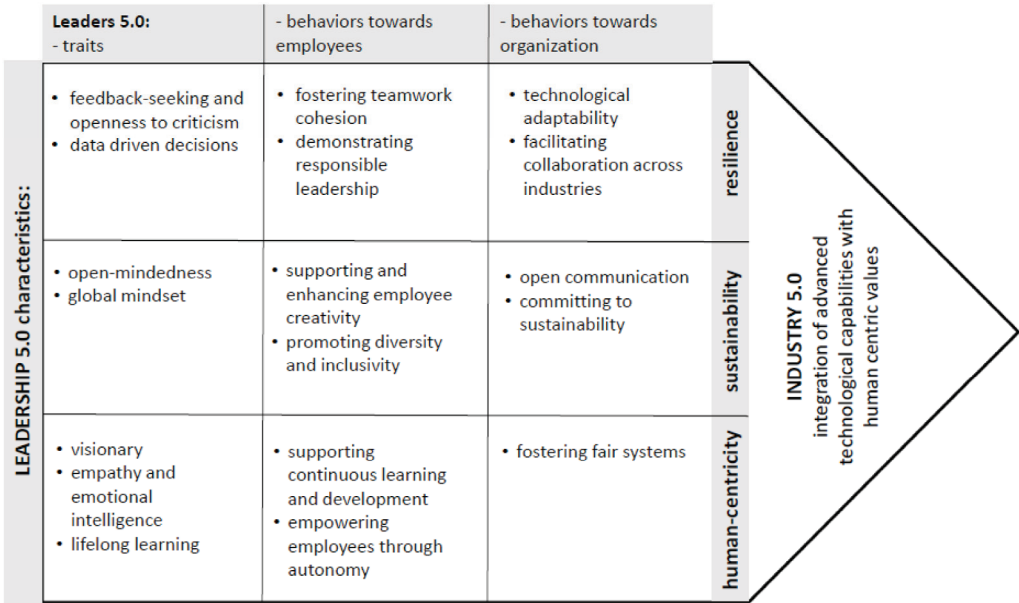


Figure 1.1. Leadership 5.0 concept
Source: based on Bienkowska et al. (2024)

The traits of leaders for Industry 5.0, as well as leaders’ for Industry 5.0 behaviors towards employees and organization should aim at fostering innovation, enhancing job performance, and maintaining human-centric values while navigating through various technological advancements (e.g., Bass and Riggio, 2006; Kouzes and Posner, 2017). Hence, the following traits are crucial for Leadership 5.0.

1.3. Individual traits of a Leader 5.0

Visionary

Visionary leaders inspire and motivate employees by providing purpose and aligning daily tasks with broader organizational goals, a hallmark of transformational leadership (Bass, 1985; Bass and Riggio, 2006). Their ability to articulate a forward-looking vision encourages employees to exceed expectations (Buss et al., 2023). Vision requires drive, often rooted in intrinsic motivation, where actions are guided by personal satisfaction rather than external rewards (Ryan and Deci, 2000). Leaders with strong drive

align goals with organizational and societal values, inspiring teams to follow suit (Kirkpatrick and Locke, 1991). In Industry 5.0, visionary leadership is crucial for strategies that integrate human-centric, sustainable, and resilient approaches to industrial transformation (Breque et al., 2021). These leaders anticipate trends, foster innovation, and navigate dynamic changes, ensuring organizations adapt and thrive.

Open-Mindedness

Open-minded leaders are tolerant of ambiguity, open to new experiences, and make independent judgments (Jacoby, 1967). They welcome diverse ideas and perspectives. Open-mindedness enables leaders to make informed decisions and foster psychological safety, job satisfaction, and organizational support among employees (Erceg et al., 2023). For Industry 5.0, which requires organizational restructuring and adaptability, leaders must be free from cognitive constraints and willing to take risks. This openness to innovation is crucial for aligning strategies with the dynamic needs of the industry and employees, especially in the context of sustainability (Judge et al., 2002; Smuts and Merwe, 2022).

Empathy and emotional intelligence

Empathy is the ability to understand and share the feelings of others, while emotional intelligence involves recognizing, understanding, and managing one's own emotions as well as those of others (Chin, 2021). Leaders who are empathetic and emotionally intelligent can create strong interpersonal relationships, promote open communication, and build trust within their teams. This helps in understanding employee needs and fostering a supportive work environment (DeRue et al., 2011; Jian, 2022). In Industry 5.0's human-centric framework, these traits are vital for creating inclusive, psychologically safe workplaces that prioritize employee well-being and integrate human aspects into technological progress (Jian, 2022; Leng et al., 2022; Wang et al., 2023).

Lifelong Learning

Leaders committed to continuous learning remain up-to-date with industry trends and new technological developments (Smith and Parsell, 2023). On top of that, leaders who are eager to learn, foster a culture of continuous learning within their organizations, which is essential for adapting to rapid changes in technology and processes

(Brown and Sitzmann, 2011; Edmondson, 2019). Lifelong learning is critical in Industry 5.0, as leaders must continuously develop skills that align with technological innovations and encourage employee development to stay competitive and innovative (Tomašević, 2023).

Global Mindset

A global mindset encompasses intellectual, psychological, and social capital, allowing leaders to navigate complex international markets seeing things from a broader, global perspective (Beechler and Javidan, 2007; Javidan et al., 2010). Leaders with a global mindset are better equipped to manage diverse teams and foster innovation by integrating diverse perspectives (Story et al., 2014). In the interconnected world of Industry 5.0, a global mindset is essential for managing multinational teams, promoting inclusive innovation, and driving sustainable outcomes on a global scale (Mohapatra et al., 2022).

Moreover, recognizing the organization as part of a broader system and being sensitive to the wider spectrum of social needs are crucial for fostering sustainability on a global scale.

Feedback-Seeking and Openness to Criticism

Leaders who seek feedback and embrace criticism promote self-improvement, better decision-making, and stronger team relationships (Ashford and Cummings, 1983; Hogan and Kaiser, 2005). This behavior fosters psychological safety and supports servant leadership, enhancing employee empowerment and autonomy (Sun and Shang, 2019) – crucial for Industry 5.0. In Industry 5.0, feedback-seeking leaders should adapt effectively to change by incorporating diverse perspectives, aligning with human-centric and innovation-driven goals, and building resilience by mitigating risks from one-sided viewpoints (Zhou et al., 2024).

Data-Driven Decisions

Data-driven leaders leverage analytical skills to make strategic, informed decisions, optimizing processes and predicting trends for a competitive edge (Salvetti and Bertagni, 2020). In Industry 5.0's data-rich environment, these capabilities are essential for driving innovation, improving efficiency, and ensuring organizational resilience while

benefiting society. Analytical proficiency is crucial for navigating the rapidly evolving industrial landscape and securing long-term success (Salveti and Bertagni, 2020).

1.4. Leaders 5.0's – behaviors towards employees

Supporting and Enhancing Employee Creativity

Leaders should focus on fostering creativity by encouraging employees to contribute innovative ideas and suggestions for improvement. By promoting creativity, leaders motivate employees to engage in innovative thinking and problem-solving. This behavior is essential for maintaining a competitive edge and driving organizational success (Hughes et al., 2018), especially due to the strengthening of innovativeness (Müceldili et al., 2013). That is because creativity fuels innovation, which is a core aspect of Industry 5.0, where the harmonization of advanced technology with human-centered values is critical. Leaders who cultivate a creative culture help organizations generate innovative solutions that align with Industry 5.0's goals and are sustainable (Tigre et al., 2024).

Promoting Diversity and Inclusivity

Inclusive leaders should actively foster a diverse and inclusive environment by inviting and appreciating contributions from team members of various backgrounds (Nembhard and Edmondson, 2006). Inclusivity enhances employee satisfaction and performance by creating a culture of belonging and respect. This, in turn, drives better decision-making and innovation (Javed et al., 2021). Industry 5.0 emphasizes diversity as a driver of innovation and better decision-making (especially in the context of induced sustainability) and leaders who promote diversity ensure that their organizations benefit from varied perspectives, improving creativity, problem-solving, and overall performance (Roberson and Perry, 2022; Shalender and Sharma, 2023).

Supporting Continuous Learning and Development

Leaders should prioritize continuous learning and development, providing feedback and opportunities to build adaptable, skilled, and innovative teams (Lundqvist et al.,

2023; Raj and Srivastava, 2016). This fosters employee engagement, retention, and long-term commitment while supporting a human-centric approach, central for Industry 5.0 (Owens and Hekman, 2012; Akdeniz and Korkmaz, 2023). In Industry 5.0, where rapid technological advancements are the norm, leaders who emphasize development ensure their teams remain prepared and resilient in a dynamic landscape, helping them stay ahead of changes and technological change (Tomašević, 2023).

Fostering Teamwork Cohesion

Leaders should promote effective teamwork by enhancing collaboration, communication, and cohesion within their teams (Montes et al., 2005). They are skilled in managing digital teams, ensuring seamless interaction across diverse and remote groups. Building cohesive teams increases job satisfaction, motivation, and performance. A leader who encourages teamwork creates an environment where collaboration thrives, leading to higher-quality work and more innovative outcomes (Griffin et al., 2001). In Industry 5.0, especially digital collaboration tools and remote working environments are prevalent and should be treated as a key for resilience. Leaders who excel in fostering teamwork across these platforms create high-performing units capable of tackling the complex challenges posed by the interconnected and digital landscape of Industry 5.0 (Salvetti and Bertagni, 2020).

Empowering Employees through Autonomy

Leaders empower employees by granting autonomy, fostering ownership, intrinsic motivation, and creativity (Chiu et al., 2023; Deci et al., 2017). Various leadership styles emphasize this approach, driving engagement and innovation (Andriani et al., 2018). Central to Industry 5.0, autonomy aligns employee motivation with human-centric values, enabling initiative and solutions that benefit organizations and society (Kumar et al., 2021; Alves et al., 2023). By promoting accountability, leaders cultivate a culture of innovation and meaningful contribution, crucial for Industry 5.0 (Alshai-bani et al., 2024).

Demonstrating Responsible Leadership

Responsible leaders prioritize social interests, environmental protection, and stakeholder engagement, aligning business goals with societal and environmental objectives (Han

et al., 2019). This approach strengthens relationships, enhances reputation, and boosts employee commitment (Suriyankietkaew et al., 2022). In Industry 5.0, which emphasizes sustainability, such leaders create long-term value and resilience by integrating responsible practices and fostering employee engagement with stakeholders, fostering social and environmental responsibility (Fortuna and Paesano, 2022; Suriyankietkaew et al., 2022).

1.5. Leadership 5.0 – behaviors towards the organization

Open Communication

Leaders should emphasize open communication, where they are not only skilled speakers but also active listeners. They create environments where employees feel valued and heard, facilitating the free exchange of ideas and feedback (Roberson and Perry, 2021). Open communication ensures that leaders can gather diverse perspectives, making better-informed decisions and solving problems collaboratively. It helps maintain transparency, enhances employee engagement, and promotes trust within the organization (Wang et al., 2023). In Industry 5.0, open communication supports open innovation, which integrates diverse perspectives and aligns technological progress with human-centered values. Leaders who foster transparent communication drive collaboration, innovation, and stakeholder engagement, which are essential for Industry 5.0 and creation of sustainable innovations (Hagen and Park, 2013; Mehta et al., 2022).

Fostering Fair Systems

Leaders should establish fair motivational systems to foster intrinsic motivation, enhancing employee creativity and performance (Saether, 2020). Fair systems of reward and recognition boost intrinsic motivation, increasing employees' engagement and creative problem-solving skills. This leads to higher innovation and job satisfaction. Creativity is essential for innovation in Industry 5.0. Leaders who promote fair motivational practices contribute to fostering an organizational culture that values employee well-being, engagement, and innovation, supporting the human-centric goals of Industry 5.0 (Saether, 2020).

Committing to Sustainability

Leaders should be committed to sustainable practices and are keenly aware of the environmental and social impacts of their initiatives (Breque et al., 2021). Committing to sustainability ensures that leaders balance technological progress with environmental stewardship and social responsibility. This strengthens the organization's reputation and long-term viability (Liao, 2022). Industry 5.0 prioritizes sustainability alongside technological advancement.

Leaders who integrate sustainable practices into their strategies contribute to a balance between innovation, environmental protection, and societal well-being, aligning with Industry 5.0's principles (Ivanov, 2023).

Technological Adaptability

Leaders should possess the foresight to anticipate the transformative effects of technologies like artificial intelligence (AI), robotics, and the Internet of Things (IoT), guiding their organizations through technological shifts (Paschek et al., 2022). By fostering adaptability, they balance technology with human creativity, enhancing innovation and problem-solving (Olsson et al., 2024). In Industry 5.0, where human talent and technological flexibility are key, leaders who integrate these elements ensure agility, competitiveness, and resilience while using technology to amplify human potential (Paschek et al., 2022; Olsson et al., 2024).

Facilitating Collaboration Across Industries

Leaders skilled in fostering cross-sector collaboration drive innovation by leveraging diverse resources and ideas (Roberson and Perry, 2021). In Industry 5.0, such partnerships enhance societal impact and align with its vision of a connected, collaborative future. These efforts also strengthen organizational resilience through balanced, informed decision-making (Roberson and Perry, 2021), crucial for proper change management.

Therefore, based on the traits and behaviors listed above, the following hypothesis can be proposed for Leadership 5.0:

H0: Leadership 5.0 is a multi-dimensional construct that is characterized by Industry 5.0 specific leaders' traits, behaviors towards employees, behaviors towards the organization.

2. Leadership 5.0 and Organizational Reliability

2.1. Organizational Reliability for Industry 5.0

Organizational reliability refers to an organization's ability to consistently perform well by minimizing errors and maintaining stability in both routine and challenging situations (Bieńkowska et al., 2020). Organizational reliability has become crucial in today's volatile, uncertain, complex, and ambiguous (VUCA) environment. It extends beyond basic performance by addressing the potential for disruptions and errors. Bieńkowska et al. (2020) introduced the Organizational Reliability Model (ORM), which focuses on organizational capabilities to enhance reliability. This model aligns with the dynamic capabilities' perspective, expanding the resource-based view by emphasizing the need to adapt resources in response to changing conditions (Teece et al., 1997; Winter, 2003; Helfat et al., 2009). Operational Capabilities are essential for day-to-day operations, involving routines that convert resources into outputs (Ivens et al., 2018). While crucial, these capabilities are not enough during abnormal situations. On the other hand, Dynamic Capabilities allow organizations to anticipate, detect, prevent, and learn from disruptions, ensuring reliability in unpredictable environments (Eisenhardt and Martin, 2000). Moreover, those capabilities are structured in three key pillars of organizational reliability: human resources reliability (ensuring employees minimize errors and perform effectively), IT reliability (maintaining error-free system functionality), and management reliability (ensuring effective leadership under all conditions) (Bieńkowska et al., 2020). Together, these elements allow an organization to function reliably, even in the face of disruptions and occurring errors.

Thus, organizational reliability goes beyond what is usually understood as organizational performance, and it is better suited for the analysis of the Industry 5.0 context, which puts resilience at its core.

Leadership 5.0 plays a pivotal role in enhancing organizational reliability, particularly within the Industry 5.0 framework, which emphasizes resilience, human-machine collaboration, and social value creation. Organizational reliability, defined as the ability to maintain stability and minimize errors under challenging conditions, is critical for ensuring sustained performance and error mitigation (Linnenluecke, 2017; Ford, 2018). Leadership 5.0 extends traditional high-reliability leadership by integrating situational leadership principles (Blanchard, 2007) with the Industry 5.0 focus on technological integration and social well-being (Kraaijenbrink, 2022), which clearly influences organizational reliability. By influencing organizational subsystems, decision-making, and error prevention, Leadership 5.0 supports both performance enhancement and error reduction, making it essential for reliability in Industry 5.0-aligned organizations (Martínez-Córcoles, 2018; Morales et al., 2019). Thus, it can be hypothesized that Leadership 5.0 positively impacts organizational reliability in Industry 5.0 contexts:

H1: Leadership 5.0 has a positive indirect effect on organizational reliability.

2.2. Influence of Leadership 5.0 on Organizational Reliability – static approach

2.2.1. Influence of Leadership 5.0 on Organizational Reliability through intraorganizational trust

Intraorganizational trust is a multidimensional construct consisting of lateral and vertical elements (McCaule and Kuhnert, 1992). It refers to the relationship between participants in an organization, especially between employees and superiors (divided into trust in employees and trust in superiors), as well as between employees of equal rank or who cooperate regardless of vertical relationships. At the same time, “trust in employees” refers to the perception held by managers that employees will act in a manner that aligns with the organization’s interests and those of their superiors. However, employees’ trust in superiors can be understood as a psychological state wherein employees have positive expectations regarding their leaders’ intentions and behaviors in situations involving risk, or they expect managers to demonstrate competence, benevolence, and fairness toward them (Bieńkowska and Tworek, 2024). In contrast, “trust between employees can be defined as positive expectations about co-workers’ intentions or behaviors with respect to each other in situations entailing risk, or the

willingness of a person to be vulnerable to the actions of co-workers whose behavior and actions that person cannot control” (Bieńkowska et al., 2018, p.12). Anytime trust in an organization has a positive connotation (I trust that you will not harm me and treat me decently) and generally refers to the probability that a person will behave as predicted. According to Sztompka (2007), “trust is a bet made on the uncertain future actions of others”. Regarding trust in leaders, one should agree with the statement that “leadership is considered trustworthy based on the leader’s behavior, integrity, use of control, ability to communicate and ability to express interest to members” (Whitener, 1998, after Hassan and Ahmed, 2011, p. 165).

The issue of intraorganizational trust, when understood in this way, is particularly relevant to the impact of leadership on the outcome parameters in an organization. Relevant here is the impact of building trust among employees and towards superiors because of the leadership process. Leaders’ traits in the concept of Leadership 5.0 (such as open-mindedness and lifelong learning, feedback-seeking and openness to criticism), as well as their indicated attitudes and behavior towards employees (supporting and enhancing employee creativity, empowering employees through autonomy), support the construction of a culture of trust. Supported by positive experiences, this should result in increased intraorganizational trust. This aligns with the human-centric values emphasized in the Industry 5.0 framework.

As for the impact of intraorganizational trust on organizational reliability, it should be highlighted that leaders’ attitude toward employees’ mistakes (as a critical area for organizational reliability) is crucial. For example, a leader who believes that making mistakes in the organization is unacceptable, and that for every detected mistake, the person should be punished – whether through a verbal admonition, a financial penalty or even (on the dark side of leadership) public humiliation – will drive employees to conceal errors out of fear. This, in turn, leads to a decline in employees’ job performance. Worse still, it does not prevent mistakes. The atmosphere of fear translates into more mistakes being made by employees, which, in sum, lowers the reliability of employees and the whole. Trust can positively influence this process. Intraorganizational trust expressed, among other things, in predictable, positive and fair treatment of employees, drops dramatically in the described situation. Bieńkowska and Tworek (2024) empirically confirmed that fake leadership, which is a manifestation of the dark side of leadership, negatively influences organizational reliability through intraorganizational trust, the number of management errors, the tendency to hide errors, and the number of employees’ errors. Assumptions about the inadmissibility of employees’ mistakes are wrong. Employees, like individuals outside of a business context, inevitably make

mistakes. The authors recommend this postulation as a basis for further actions in organizations aligned with the human-centric principles of Industry 5.0, which prioritize the overall well-being of employees. Hence, instead of creating an atmosphere of fear, it is necessary to create an atmosphere of trust in the organization. Leaders should communicate that it is natural to make mistakes, but everyone should strive to minimize them, learning from mistakes and the situations that have arisen. The leader's task is to motivate employees using positive reinforcement to avoid making mistakes, to take preventive measures and to learn from them when they occur to eliminate them in the future. The component of building intraorganizational trust is, therefore, a key element of the Leadership 5.0 concept, contributing directly to organizational reliability. Accordingly, the following hypothesis is proposed:

H2a: Leadership 5.0 influences organizational reliability through organizational trust in organizations implementing the Industry 5.0 framework.

2.2.2. Influence of Leadership 5.0 on Organizational Reliability through sustainable innovation

Sustainable innovation. Industry 5.0 complements the existing Industry 4.0 approach by specifically putting research and innovation at the service of the transition to a sustainable, human-centric and resilient industry (Breque et al., 2021). Innovations aligned with the Industry 5.0 priorities are predominantly termed as sustainable. Afeltra et al. (2022, p. 144), summarising all the different approaches to sustainable innovation from the organizational perspective, define them as “the implementation of new ideas, capabilities, processes and products that reduce or avoid environmental impact for the benefit of the community, while at the same time trying to make profit, contributing to the sustainable advantage of the firm.” This definition clearly aligns sustainable innovation with the Industry 5.0 framework, where sustainability is one of the main pillars. Additionally, Tello and Yoon (2008) emphasize human well-being as an objective of sustainable innovation, linking to another Industry 5.0 priority – human centricity and social well-being. Bos-Brouwers (2010), in turn, underlines the long-term perspective of sustainable innovation, coming from the definition of “sustainability” by highlighting the capacity of sustainable innovation to generate social and environmental impact “both in the short and long term”.

Based on the systematic literature review, Cillo et al. (2019) suggest that sustainable innovation can be seen through three perspectives: internal managerial, external relational, and performance evaluation.

Previous research on the internal managerial perspective includes attempts to identify the type of innovations that lead to sustainability and the corresponding business models, management strategies, and practices. Those findings suggest the characteristics of the leadership styles that could support sustainable innovation and, to a considerable extent, resemble the characteristics of Leadership 5.0 described above. Nasiri, Tura, and Ojanen (2017) argue that incremental innovations are not enough to reach Sustainable Development Goals, and therefore, disruptive innovations are needed to create new values and markets. Thus, an open-minded visionary with a global mindset and an ability to see the future trends and Industry 5.0 perspectives might be needed to foster these innovations within the organization. At the same time, sustainable innovation is associated with higher risks and a greater probability of error. Longer planning horizons and the ability to work in high uncertainty and learn from experience allow for better balancing economic, environmental, and social impacts and, therefore, help implement sustainable innovation (Longoni and Cagliano, + 2018). These managerial practices would expect to utilize specific Leadership 5.0 characteristics, which include eagerness to learn, taking criticism openly and appreciating feedback. Another internal managerial aspect worth mentioning is the effective utilization of information systems. Despite limited evidence on specific information system attributes supporting sustainable innovation (Stahl et al., 2014), managers' skills in data analysis, data-driven decision-making, and digital team management align with Watson, Boudreau, and Chen's (2010) argument. They suggest, that information systems positively contribute to sustainable innovation by facilitating virtual collaboration and cooperative knowledge management.

The external rationale for sustainable innovation spotlights the crucial role of inter-stakeholder relationships and deeper collaboration of the organization with internal and external stakeholders, including not only direct partners/customers but also competitors and other players of the innovation ecosystems (Cillo et al., 2019). That brings our attention to the ability of leaders for Industry 5.0 to build relations and encourage employees to engage with various groups: clients, employees, and the local community. It also requires that the organization possesses skills in fostering collaboration and partnerships across industries and sectors.

When discussing performance evaluation, sustainable innovation as an objective for organizational management is a tool to obtain a competitive advantage and ensure business sustainability and reliability. Sustainable innovation can enhance organizational reliability when supported by an appropriate leadership approach. Fragouli and Chukwudum (2019) conceptualize this viewpoint through the Responsible Leadership

Model. In this model, leadership is both a style and an objective, focusing on making decisions that align with the interests of all stakeholders, including clients, employees, workers, suppliers, the community, and the global environment, while also considering the priority of Industry 5.0 – the well-being of future generations. The following hypothesis is therefore possible:

H2b: There is a positive influence of Leadership 5.0 on organizational reliability through sustainable innovation in organizations implementing the Industry 5.0 framework.

2.2.3. Influence of Leadership 5.0 on Organizational Reliability through creativity

Creativity. Creativity is generally understood as the ability to develop new and valuable ideas (Kaufman and Stenberg, 2010). It involves a mix of cognitive processes, personal traits, motivation, and environmental influences. Creativity can be seen at various levels, including individual, team, and organizational (Guilford, 1950; Torrance, 1965). Key aspects of creativity include generating numerous ideas (fluency), seeing different uses for ideas (flexibility), coming up with unique and uncommon ideas (originality), and building on existing ideas (elaboration) (Ivancovsky et al., 2021).

In the context of Industry 5.0, influenced by the creativity-centered approach of Society 5.0, creativity becomes an important component, which drives innovation and ensures that technological progress aligns with human-centric values (Salgues, 2018; Huang et al., 2022; Scuotto et al., 2023). Industry 5.0 stresses the importance of balancing technology with humanistic values like empathy, creativity, critical thinking, and personal responsibility (Fialkowska-Filipek and Dobrowolska, 2023; Magni et al., 2024). The goal is to combine human experts' creativity with intelligent machines' precision, bringing back the "human touch" to the industry (Nahavandi, 2019). This collaboration is expected to enhance quality by assigning repetitive tasks to machines while leveraging human creativity for tasks requiring critical thinking (Pereira et al., 2020; Leng et al., 2022; Maddikunta et al., 2022).

Holford (2019) criticises the prevailing focus on efficiency and maximisation in digital transformation strategies, advocating for a more human-centred approach that values creativity and tacit knowledge. He argues that while technological advancements can help with specific tasks, they cannot replicate the holistic and symbolic nature of human creative processes. The human-centric approach of Industry 5.0 aligns

with this perspective, adapting to human needs and enhancing creative capacities. Technologies such as AI, big data, and robotics should not be perceived merely as tools for automation but as enablers of creative problem-solving and innovative output, enhancing human creativity instead of replacing it (Breque et al., 2021). It is essential to create an environment that encourages innovation and the free exchange of ideas to foster creativity within an organization. This can be achieved through supportive leadership, continuous learning opportunities, and a culture of inclusivity and psychological safety (e.g., Nembhard and Edmondson, 2006; Owens and Hekman, 2012; McMahon and Ford, 2013; Jaiswal and Dhar, 2015; Hughes et al., 2018). That brings us to the third hypothesis:

H2c: There is a positive influence of Leadership 5.0 on Sustainable Innovation through Creativity in organizations implementing the Industry 5.0 framework.

2.2.4. Influence of Leadership 5.0 on Organizational Reliability through collaboration

Collaboration. Collaboration (also referred to as integration cooperation) plays a unique role in the global and interconnected nature of Industry 5.0. The goal is to achieve enhanced efficiency of the elements, ensuring the system is balanced and capable of providing sustainable, long-term outcomes (e.g., Breque et al., 2021; Xu et al., 2021; Magni et al., 2024). Collaboration can occur within and across industries, organizations, disciplines, and departments (e.g., Nahavandi, 2019; Leng et al., 2022; Maddikunta et al., 2022; Barata and Kayser, 2023). It also refers to different elements of organizational systems, such as humans and technology (e.g., Nahavandi, 2019; Welfare et al., 2019; Leng et al., 2022), and the spheres in which organizations operate – physical and virtual (Breque et al., 2021; Maddikunta et al., 2022).

Transitioning from the efficiency and technology-driven Industry 4.0 to a more human-centric Industry 5.0, there is a significant emphasis on the need for inter-departmental and interdisciplinary collaboration and the integration between humans and advanced technologies. Rahmawati et al. (2021) argue that collaboration, along with skills such as communication, critical thinking, citizenship, character, and creativity, must be developed within human resources to balance existing technological advancements. Papetti et al. (2020) highlight that redesigning industry systems towards human-centric connected systems, which aim to enhance workers' well-being, health, satisfaction, and performance, necessitates multidisciplinary intersected expertise.

Leng et al. (2022) emphasize the importance of adopting an interdisciplinary approach across engineering, technology, life sciences, environmental and social sciences, and humanities. By collaborating, different disciplines can leverage each other's strengths and address each other's weaknesses, creating a dynamic and interconnected network.

Collaboration is one of the key aspects of achieving sustainable innovation. Gomathi et al. (2023) emphasize that bringing together diverse perspectives enhances innovation, creativity, and problem-solving, leading to fresh ideas that may not emerge in a homogenous environment. Smuts and Merwe (2022) state that knowledge must be shared and transferred for organizations to be innovative. Bednar et al. (2020) emphasize that collaboration within departments enhances the ability of teams and individuals to share their contextual understanding, involving collaborative data interpretation, reflection on insights, and collegial exchange and report analysis. According to Wolf and Erfurth (2019), integrating diverse organizational characteristics supports the creation of innovative, differentiated solutions. Kasinathan et al. (2022) underline that the more effective the collaboration, the better the workforce in terms of safety and productivity. Ivanov (2023) states that collaborative efforts enable adaptivity and the ability to effectively respond to disruptions. Collaboration enhances innovation and problem-solving capabilities, leading to resilient and sustainable industrial systems.

Leadership that supports the creation of inclusive workplaces, values diversity, and encourages open communication plays a crucial role in fostering collaboration. According to Roberson and Perry (2021), inclusive leadership creates an environment where employees feel valued and included, allowing them to contribute their unique insights and collaborate effectively. By reducing status differences and promoting equity, inclusive leaders ensure that all voices are heard, enhancing collaboration. Van der Voet and Steijn (2020) emphasize that visionary leadership contributes to organizational cohesion by fostering a collective commitment to shared goals. This cohesive environment facilitates open communication and mutual trust, which is essential for effective collaboration and innovation. When employees are aligned with a shared vision and feel a sense of belonging, they are more likely to share knowledge, support each other, and collaborate on innovative solutions. This allows us to formulate the following hypothesis:

H2d: There is a positive influence of Leadership 5.0 on sustainable innovation through collaboration in organizations implementing the Industry 5.0 framework.

2.2.5. Indirect static influence of Leadership 5.0 on Organizational Reliability

In a static approach, Leadership 5.0 strengthens organizational reliability by cultivating a stable foundation of creativity, collaboration, and trust within the organization. These elements act as enduring enablers of sustainable innovation, ensuring that new ideas emerge, are shared effectively, and are supported by mutual confidence among stakeholders. Trust further reinforces reliability both directly and indirectly by reducing uncertainty and enabling consistent performance. Through these steady, interlinked mechanisms, Leadership 5.0 creates a supportive culture that embeds innovation and reliability into the organizational fabric, maintaining stability and continuity rather than focusing on dynamic adaptation. Hence, the main hypothesis concerning the static influence of Leadership 5.0 on organizational reliability (see Fig. 2.1) is as follows:

H2: Leadership 5.0 influences organizational reliability through creativity, integration, sustainable innovation and intraorganizational trust in organizations implementing the Industry 5.0 framework.

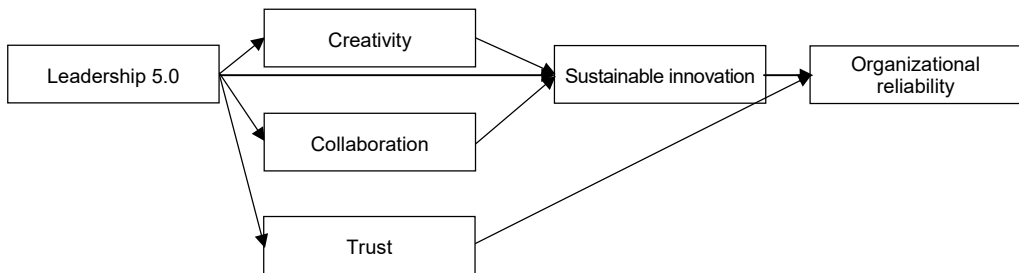


Figure 2.1. The model of Leadership 5.0 influence on organizational reliability – static approach

2.3. Influence of Leadership 5.0 on Organizational Reliability – dynamic approach

2.3.1. Influence of Leadership 5.0 on Organizational Reliability through EDCs

The context of Industry 5.0 is characterized by the dynamic nature of the external VUCA environment of business operations and the changing level and scope of tech-

nological advancements. Dynamic capabilities enable the organization to respond to dynamic changes in the environment, enhancing its effectiveness (Helfat et al., 2009; Teece and Pisano, 1994). Individual employees and their human capital are not only one of the cornerstones of dynamic capabilities (Eisenhardt and Martin, 2000) but also a facilitator of dynamic capabilities at the organizational level (Adner and Helfat, 2003). Employees Dynamic Capabilities (EDCs) are viewed as a multidimensional concept (Tworek et al., 2023a) encompassing the ability to be sensitive to change in the environment, the ability to adapt to changes in the environment, the ability to proactively solve problems and include innovations and the ability for personal development and learning (Bieńkowska and Tworek, 2020). Therefore, they are crucial in the dynamic context of Industry 5.0, where change is constant, and leaders must foster an agile, resilient, and sustainable approach (Botti and Baldi, 2024).

As shown by scholars, various leadership styles can directly or indirectly impact dynamic capabilities (Lopez-Cabrales et al., 2017). We believe that Leadership 5.0 actively fosters EDCs by creating a supportive environment, promoting learning, and empowering employees to take initiative, adapt, and innovate. Leadership 5.0 is designed to align human-centric, resilient, and sustainable leadership practices with organizational goals shaped by the dynamic nature of the Industry 5.0 context. This alignment makes EDCs a natural extension of Leadership 5.0 values and practices, as it equips employees with the skills needed to react quickly, adapt to new challenges, and cultivate dynamic responses to changing environments.

Moreover, scholars have argued that enhancing EDCs can improve organizational outcomes (Chatterjee et al., 2022). Kurtmollaiev (2020) states that recognizing individual dynamic capabilities can enhance understanding of how organizations adapt and thrive in changing environments. This underscores the indispensable contemporary dynamic nature of the resources at an organizations' disposal. In the case of EDCs, this refers directly to human resources, which today are critical to achieving the goals of the organization (Armstrong and Taylor, 2023; Bieńkowska et al., 2022). Research has demonstrated the importance of the EDCs concept, showing that EDCs not only impact job performance (Al Wali et al., 2023; Bieńkowska and Tworek, 2020) but also has implications at the organizational level, especially organizational performance (Tworek et al., 2023b). The results also show that EDCs affect organizational reliability (Bieńkowska and Tworek, 2020). Each time, however, the influence is shown to be indirect, which is unsurprising since EDCs represent employees who constitute only one part of the organization. Given the above, studies have identified a statistically significant positive relationship between EDCs and innovative work behavior (Al Wali

et al., 2023). Chaudhuri et al. (2023) further expanded on the concept of EDCs, exploring it as an employee knowledge capability and skill enhancement factor, which they found to be linked to employees' readiness to adopt digital technology. In addition, they allow employees to develop their digital capabilities (Wang et al., 2024a), enhancing job performance and organizational resilience in dynamic markets (Wang et al., 2024b). Furthermore, the research conducted by Wang et al. (2024b) suggests that the presence of strong EDCs may contribute to building a more resilient and adaptable organization – essential elements of reliability in a competitive landscape. All the abovementioned elements influence organizational reliability to a larger or smaller extent. Shaping organizational reliability requires strong leadership, clear communication, and a well-defined structure of processes and protocols that allow the organization to anticipate, prevent, and quickly recover from failures (Tworek et al., 2020; Weaver, 2015). This involves fostering a culture of accountability, continuous learning, and adaptability (Weick, 1987; Sullivan and Beach, 2012), where employees are empowered to address problems proactively and implement improvements. As a result, EDCs gain the potential to influence organizational reliability. Organizational reliability depends on a workforce that can respond effectively and consistently to uncertainties, maintaining performance and resilience. In this way, EDCs act as a mediator by translating Leadership 5.0 into practical, adaptive actions at the employee level.

Given the above, when employees possess strong dynamic capabilities, they are better equipped to absorb and apply the guidance from Leadership 5.0, making the organization more robust and reliable in the face of change. Thus, EDCs become the bridge through which Leadership 5.0 influences organizational reliability by enabling employees to adapt leadership-driven strategies into resilient, reliable practices. Hence, the following research hypothesis has been formulated:

H3a: EDCs influenced by Leadership 5.0 have a positive indirect effect on organizational reliability.

2.3.2. Influence of Leadership 5.0 on Organizational Reliability through IT adaptability

IT adaptability has emerged as a critical capability for modern organizations, especially in response to the rapid technological advancements and evolving operational landscapes characteristic of Industry 5.0. Nowadays, organizations must navigate numer-

ous shifts, including integrating human-centric technology, digital transformation, and sustainability-focused innovation. From a broader organizational perspective, adaptability refers to the capacity to adjust effectively to changes in user demands or environmental conditions (Almutairi and Ghandour, 2021). Similarly, in IT, adaptability is “the degree to which a product or system can effectively and efficiently be adapted for different or evolving hardware, software, or other operational or usage environments” (ISO/IEC 25010:2023).

Okanga and Groenewald (2019) state that IT adaptability is shaped by specific qualities inherent to IT systems, categorized into system- and organization-based factors. System-based factors – such as scalability, modularity, interoperability, and availability – underscore the flexibility of the IT infrastructure’s technical capabilities. Organization-based factors, including structural analogy, knowledge-sharing, redundancy, and customization, highlight how IT adaptability is enhanced through strategic organizational deployment. As Tworek (2023b) notes, IT adaptability is not solely dependent on technical infrastructure attributes. It is strongly influenced by organizational factors which play a critical role in determining how effectively IT systems respond to changing demands. From this perspective, adaptability is shaped mainly by organizational culture, decision-making processes, and leadership approaches, which guide the integration of IT into daily operations and strategic goals. Consequently, IT adaptability can be understood as a collaborative and dynamic process requiring structures, alignment with organizational priorities, and supportive leadership.

Leadership plays a critical role in the digital landscape of Industry 5.0, grounded in tight human-machine collaboration. Patten et al. (2005) suggest that while the technical capabilities of IT systems are foundational, true adaptability depends significantly on how individuals engage with and apply technology within the organizational context. They introduce the IT Flexibility Framework, encompassing anticipation, agility, and adaptability, all of which require active human engagement to respond to environmental changes effectively. This is further supported by Kane et al. (2015), who argue that effective digital transformation relies not only on technological advancements but also on strategic leadership capable of aligning these technologies with broader business goals. They emphasize that leaders must possess a clear strategic vision and the ability to bridge gaps in technical knowledge, as effective leadership is essential to fully leveraging new technological capabilities and driving successful transformation efforts.

Leadership is essential in navigating complex environments by fostering adaptability across organizational levels (Uhl-Bien and Arena, 2018). As Dahlstrom et al. (2017)

highlight, digital transformation disrupts routine processes and requires strategic vision, stakeholder alignment, and resource allocation from leaders to implement adaptable IT systems successfully. Leaders who envision future digital landscapes and inspire change are critical to creating adaptable IT systems that respond dynamically to technological and human needs, ultimately enhancing organizational resilience and stability (Demirkan et al., 2016). Leadership 5.0 is a unique competency set that blends strategic foresight with an adaptive, human-centered approach. McCarthy et al. (2022) emphasize that leaders must act as digital architects, cultivating agility and resilience within their teams while promoting a culture that embraces change. By integrating roles such as digital strategist and organizational agility, leaders ensure that their IT systems are responsive to evolving needs.

Moreover, IT adaptability is a crucial component of organizational reliability, as it enables organizations to respond swiftly and effectively to changing conditions (Tworek, 2023a). Similarly, as in the case of EDCs, the necessary contemporary dynamic nature of the resources at the disposal of the organization is highlighted here – here in the field of IT, which, especially in the concept of Industry 5.0, determines the effectiveness of achieving the goals of the organization. As in the case of EDCs, it is possible to speak of indirect influence here, since IT is one of the organization's resources. IT adaptability provides organizations with the technological flexibility needed to support strategic adjustments, enable agile decision-making, and respond effectively to evolving environmental demands (Darvishmotevali and Ali, 2020; Wanasida et al., 2021). Adaptable IT systems would allow leaders to make quick, data-driven decisions that align with shifting business strategies, fostering a culture of responsiveness and maintaining consistent performance (Stank and Lackey, 1997; Cash and Konsynski, 1985). In this way, it supports operational continuity and empowers organizations to leverage continuous improvements in technology and processes (Patterson et al., 2003). By facilitating integration and supporting ongoing adjustments, adaptable IT enhances sustainability and organizational robustness in the face of continuous change (Zeng and Lu, 2021).

In Industry 5.0, adaptable IT is also essential for job performance as employees increasingly rely on technology to perform their tasks effectively (Breque et al., 2021). IT adaptability allows for task redesign and facilitates efficient workflows, enabling employees to integrate new technological tools into their roles with minimal disruption (Patten et al., 2005). This adaptability reflects the centrality of the employee-IT relationship in modern organizational models, where employees' engagement with adaptable IT drives organizational success. Studies indicate that when employees embrace

adaptable IT (Kabra et al., 2017), it positively impacts organizational performance. Therefore, IT adaptability serves as a mediator by transforming Leadership 5.0 into actionable, adaptive practices at the employees and organizational level.

Given the established connection between IT adaptability, leadership, and organizational reliability, the role of Leadership 5.0 becomes increasingly evident. Leadership 5.0, characterized by attributes like strategic vision, data-driven decision-making, and a human-centered approach, directly influences IT adaptability by fostering a supportive environment that enhances organizational reliability. Thus, we propose the following hypothesis:

H3b: IT adaptability influenced by Leadership 5.0 has a positive indirect effect on organizational reliability.

2.3.3. Influence of Leadership 5.0 on Organizational Reliability through EDCs, IT adaptability, and Intrapreneurship

The role of EDC and IT adaptability on organizational reliability, as described earlier, is indirect and is further moderated by intrapreneurship, which fosters internal innovation and adaptability.

Intrapreneurship refers to the practice where employees within an organization act as entrepreneurs. They identify opportunities, create innovative solutions, and drive changes that add value to the company. This concept gained prominence in the 1980s, as scholars and business leaders recognized the importance of fostering entrepreneurial behavior within established organizations (Pinchot, 1985; Guth and Ginsberg, 1990; Stopford and Baden-Fuller, 1994; Drucker, 2017). Unlike traditional entrepreneurship, which involves starting new businesses independently, intrapreneurship occurs within the structure of an existing organization (Morais et al., 2021; Deprez, 2024).

Early definitions of intrapreneurship by Burgelman (1983) and Jennings and Lumpkin (1989), followed by Gawke et al. (2019), focused on intrapreneurship as firms' actions towards diversification through internal development and activities like product and technological innovation. In the 1990s, a more comprehensive definition emerged, encapsulating intrapreneurship as corporate venturing and strategic renewal activities driven by employees' intrapreneurial behaviors (Stopford and Baden-Fuller, 1994). Corporate venturing involves creating and integrating new businesses within the organization, while strategic renewal is about seeking opportunities and competitive advantages to improve the organization's position in the market (Guth and Ginsberg, 1990).

Intrapreneurship plays a critical mediating role, linking Leadership 5.0 and organizational reliability within the Industry 5.0 paradigm.

Leadership 5.0 practices directly influence intrapreneurship skills and foster intrapreneurial behavior by supporting and enhancing creativity, allowing employees to experiment creatively with their new ideas (Lumpkin and Dess, 1996) and arrive at creative solutions (Kropp et al., 2008). Driven by the cross-sectoral nature of Industry 5.0, Leadership 5.0 facilitates collaboration across industries and, therefore, increases the intrapreneurial intentions of employees through networking. The latter has been recognized as an important factor of intrapreneurship (Aldrich, 1999; Lau et al., 2012). Autonomy and supportive leadership are antecedents to intrapreneurship. Therefore, responsible behavior toward employees and their empowerment through autonomy, demonstrated by Leadership 5.0, are the types of actions required to increase the number of employees with entrepreneurial skills and competencies. In addition, researchers argue that responsible leadership helps create an environment that is safe for employees' risk-taking and innovation (Nembhard and Edmondson, 2006; Hollander, 2012; Edmondson, 2019; Zhong et al., 2021).

Companies operating within the Industry 5.0 recognize intrapreneurship as a key component of their talent development strategies, aligning with the core pillars of Industry 5.0: human-centricity, sustainability, and resilience. An entrepreneurial mindset thriving for continuous self-improvement and development ensures that employees remain open to upskilling and reskilling to adapt to evolving technological realities. It influences organizational outcome parameters, particularly organizational performance (Wiklund and Shepherd, 2003; Felicio et al., 2012; Antoncic and Hisrich, 2001). It has also been demonstrated that it reduces the occurrence of internal errors and failures within organizations when improved collaboration and communication across teams and stakeholders accompany the intrapreneurship process (Carlson and Wilmot, 2006). Effective intrapreneurship within an organization also utilises a dynamic and adaptive approach to suggesting and implementing solutions at each stage of development to ensure continuous improvement of initiatives to address obstacles quicker and to target error and loss minimisation (Christensen and Raynor, 2003; Rivera, 2017). In turn, employees' entrepreneurial skills related to threat recognition and adaptability add to the organization's resilience in response to the VUCA environment. This indicates that intrapreneurship is a crucial component of organizational reliability.

Similarly, as previously noted, this impact is indirect. Intrapreneurship influences organizational reliability by fostering a proactive organizational culture, encouraging

innovative problem-solving, and aligning operational processes with strategic goals (Kane et al., 2015). The ability of internal entrepreneurs to identify opportunities for new sustainable business processes and customer solutions enables companies to achieve their sustainability goals through sustainable innovation. Therefore, intrapreneurship demonstrates an indirect influence on organizational reliability, and we will explore this indirect effect through sustainable innovation in following sections.

2.3.3.1. Influence of Leadership 5.0 on Organizational Reliability through EDCs and Intrapreneurship

As detailed previously, Leadership 5.0 drives EDCs by fostering an organizational culture that supports innovation, creativity, and entrepreneurial capabilities. EDCs, in turn, act as critical enablers of intrapreneurship by providing the necessary resources and environment for employees to engage in entrepreneurial activities. This pathway demonstrates that Leadership 5.0, by fostering EDCs, indirectly enhances organizational reliability through the mediating effect of intrapreneurship.

EDCs directly influence intrapreneurship due to the nature of the dynamic capabilities. Being sensitive to change in the environment as part of the EDCs allows employees to quickly notice and successfully recognize opportunities and threats in the environment, both inside and outside the organization. In the VUCA environment, accompanied by following the Industry 5.0 concept, this ability of employees to stay vigilant and aware of their surroundings is critical for the organization's success. Those who can identify opportunities, such as emerging market trends, and threats, like potential disruptions, enable the organization to stay ahead of competitors. Early recognition allows the organization to capitalize on opportunities or mitigate threats before they escalate into significant challenges (Hart, 2024).

The ability to adapt to changes in the environment within EDCs can foster an intrapreneurial mindset, moving beyond merely adapting to the identified opportunities and threats. This adaptability may involve reconfiguring work processes, embracing new technologies, or even redefining strategic priorities to maintain competitiveness and innovation.

Employees who can pivot and adjust their behaviors to align with new realities help the organization maintain competitive advantage and resilience (Antonicic and Hisrich, 2001; Berzin et al., 2016) – aspects of organizational reliability highly prioritized within the Industry 5.0 concept.

EDCs imply employees' ability to solve problems as they arise proactively. Being already open to such a proactive behavior, they will be ready to demonstrate an entre-

preneurial approach and seek necessary resources and support for prompt problem-solving in case of inefficiencies, conflicts, or technical difficulties, which are widespread within Industry 5.0 context, requiring broad human-machine interaction and large-scale implementation of advanced technologies. Timely reaction to these issues is essential in maintaining smooth and effective operations (Berzin et al., 2016) and ensuring organizational reliability.

Finally, constantly developing competencies and raising qualifications underscores the importance of personal growth and continuous learning in intrapreneurship. Employees who demonstrate personal development and learning capability as part of the EDCs ensure they remain valuable assets to the organization, capable of driving and implementing innovative changes. This ongoing development is crucial for sustaining the intrapreneurial spirit and ensuring the organization remains dynamic and adaptable in a rapidly changing business environment (Berzin et al., 2016).

Moreover, EDCs play a mediating role in the influence of Leadership 5.0 on intrapreneurship. Successful intrapreneurship, which is seen as a prerequisite for organizational success (Rahmah and Fatman, 2019), requires Leadership 5.0 approaches – guarantee for employees' autonomy to innovate (Farrukh et al., 2019), open communication and fair systems to ensure quality-based relations (De Jong et al., 2011) and leader-member exchange (Moin et al., 2022). Such autonomy to innovate fosters EDCs in terms of proactively solving complex problems and is considered the essence of intrapreneurship within an organization (Jatin et al., 2020).

The influence of Leadership 5.0 on intrapreneurship is also mediated by EDCs due to the dynamic nature of the latter. It makes employees expect and be ready for change and, therefore, look for new solutions suitable for the emerging context. Such an attitude ensures intrapreneurial behavior at the workplace and regarding the company's products and services. Characteristics of dynamic capabilities are at the core of intrapreneurial behavior and skills formation. Intrapreneurial behavior of the employees includes recognizing opportunities and threats and effectively adapting to them; noticing and identifying problems in the workplace and demonstrating speed and efficiency in solving those problems; generating innovative solutions; and constantly improving individual competencies and qualifications. Thus, the impact of Leadership 5.0 on intrapreneurship is mediated through EDCs. Moreover, EDCs and intrapreneurship play a critical mediating role, linking Leadership 5.0 and organizational reliability. EDCs, transformed into intrapreneurial behavior within organizations, can enhance an organization's performance (Skarmeas et al., 2016), help to measure the effectiveness of the employee's actions (Antoncic and Hisrich, 2001; Neessen et al., 2018), and

their impact on organizational reliability. By fostering innovation and adaptability, intrapreneurship enhances organizational resilience and ensures sustained performance. Therefore, intrapreneurship further enhances the mediating role of EDCs in channeling Leadership 5.0 into organizational reliability by fostering innovation and proactive behaviors within the organization.

Building on the recognized relationship between Employee Dynamic Capabilities (EDCs), intrapreneurship, leadership, and organizational reliability, the significance of Leadership 5.0 becomes increasingly apparent. Leadership 5.0, defined by its responsible approach, promotion of diversity and inclusion, enhancement of creativity, empowerment of employees through autonomy, and facilitation of cross-industry collaboration, plays a pivotal role in fostering intrapreneurship. EDCs provide the foundation for entrepreneurial employees to develop creative, risk-taking, and timely innovative solutions within the workplace, ultimately contributing to organizational reliability. Based on this, we propose the following hypothesis:

H3c: Intrapreneurship, influenced by Leadership 5.0 and EDCs, has a positive indirect effect on organizational reliability.

2.3.3.2. Influence of Leadership 5.0 on Organizational Reliability through IT adaptability and Intrapreneurship

As detailed previously, Leadership 5.0 drives IT adaptability by promoting a culture that embraces technological innovation, flexibility, and continuous learning. IT adaptability, in turn, acts as a critical enabler of intrapreneurship by equipping employees with the tools, systems, and digital resources necessary to engage in entrepreneurial activities. This pathway demonstrates that Leadership 5.0, by fostering IT adaptability, indirectly enhances organizational reliability through the mediating effect of intrapreneurship.

IT adaptability has a direct influence on intrapreneurship. As Industry 5.0 is highly formed by technological advancements, primarily based on digital technologies and other types of deep tech (EIT, 2023), the ability to efficiently adapt to technological changes while prioritizing simultaneously all dimensions of Industry 5.0 will result in an intrapreneurial mindset and actions that are both human-centric and technologically advanced. Moreover, employees and organizations with high levels of IT adaptability can easily follow the effectuation approach (Sarasvathy, 2024) to introduce changes in the workplace and within the product/service portfolios, being open to cross-industry cooperation, taking affordable risks and using external challenges to the

benefits of the organization. In a digitalized landscape shaped by Industry 5.0, IT adaptability facilitates the seamless integration of new technologies, ensuring that systems can respond to shifting business requirements and environmental demands (Almutairi and Ghandour, 2021; Tworek, 2023b). Adaptable IT systems support agile decision-making and allow organizations to make real-time data-driven adjustments. IT adaptability, therefore, will create no limits to any new solutions in hardware, software, or other business and operational environments.

IT adaptability also plays a mediating role in the influence of Leadership 5.0 on intrapreneurship. It ensures the alignment of internally initiated changes and innovations based on technological integration with strategic priorities and promotes a culture that embraces change (Kane et al., 2015). Besides, leaders with a strategic vision and an understanding of digital transformation based on deep tech and Industry 5.0 allow for the enlargement of a new employee group – technology intrapreneurs (Menzel, 2007). Adaptable IT systems can be referred to as a part of the physical environment necessary to promote intrapreneurship among engineers.

At the same time, intrapreneurship, supported by IT adaptability, plays a critical mediating role, linking Leadership 5.0 and organizational reliability through enhancing organizational resilience and stability. Intrapreneurship, supported by IT adaptability, primarily due to its ability to enhance the responsiveness and flexibility of organizational systems, enable employees to effectively leverage opportunities for innovation and improvement, and align technological advancement with organizations' strategic vision (Kane et al., 2015).

Thus, intrapreneurship amplifies the mediating effect of IT adaptability in translating Leadership 5.0 into organizational reliability by encouraging technology-related intrapreneurship and leveraging the adaptability of the organization's IT systems for searching an appropriate pathway to mitigate risks and use opportunities of the VUCA environment. As a result, this brings us to the hypothesis:

H3d: Intrapreneurship, influenced by Leadership 5.0 and IT adaptability, has a positive indirect effect on organizational reliability.

2.3.4. Influence of Industry 5.0 on Organizational Reliability through EDCs, IT adaptability, intrapreneurship, and sustainable Innovation

Building on the pathways discussed previously, this section integrates sustainable innovation as a critical mediator linking Leadership 5.0 to organizational reliability. Sustainable innovation leverages the enablers of EDCs, IT adaptability, and intrapreneurship.

neurship to drive long-term organizational resilience, adaptability, and environmental responsibility. This section explores two pathways where Leadership 5.0 influences organizational reliability indirectly through these mediators.

Sustainable innovation, as defined by Adams et al. (2016), is distinguished from conventional innovations and implies that economic, social, and environmental considerations are integrated into the whole innovation process from idea generation through research and development to commercialization. This holistic approach is increasingly recognized by researchers and practitioners as essential for companies willing to ensure their long-term organizational reliability (Nidumolu et al., 2009; Adams et al., 2016; Dommerholt et al., 2021; Guggenberger, 2023; Bohlin et al., 2023) and fully aligns with the Industry 5.0 concept (European Commission, 2021).

Adams' model (Adams et al., 2012) of sustainably oriented innovation emphasizes the various levels at which organizations can implement these practices. For organizations operating in rapidly changing environments, it is crucial to adopt sustainable innovation at the highest level – system-building sustainable innovation. This level is characterized by increased sustainability of introduced solutions, socio-technical rather than purely technical approach, integrated innovation processes embedded within the organization's culture (Nidumolu et al., 2009) and operational strategies, and an equal prominence of the Triple Bottom Line (TBL). This systemic approach, which includes broadening the scope of innovation beyond the confines of R&D, allows organizations to maintain and enhance their reliability in the face of external pressures and uncertainties.

Successful implementation of sustainable innovation implies the direct and indirect influence of strong leadership. Any sustainable innovation activity requires specific competencies to succeed in different stages of the sustainable innovation path. Nidumolu et al. (2009) mention skills to work with other companies, including competitors; commitment to sustainability; promotion of social and environmentally friendly innovations; the global mindset and capacity to understand consumer wants, partners' potential, and values. Edmondson (2019) insists that solutions for emerging issues require global cross-sector and cross-disciplinary collaboration within an emotionally safe working environment. According to Guggenberger (2023), leaders need to think longer term, cultivate fit-for-purpose behavior, and inspire their employees while demonstrating more trust and giving them more power to make decisions.

Finally, the role of Leadership 5.0. in implementing sustainable innovation is additionally mediated by intrapreneurship. Researchers emphasize that Leadership 5.0's ability to promote diversity and inclusion also contributes to creativity and innovation

(Luu, 2019), as an inclusive climate increases team innovation (Nishii, 2013) and the dynamics of innovative behavior (Lambert, 2016). Nurturing the company's intrapreneurship culture by promoting creativity, learning, and development and empowering autonomy, Leadership 5.0 ensures that employees are willing to innovate. Those individuals, in turn, contribute to a continuous flow of innovations beyond the scope of their duties, reinforcing organizational reliability (Parker et al., 2006).

The impact of sustainable innovation on organizational reliability in the dynamic environment is multifaceted. Sustainable innovation directly contributes to organizational reliability. Economically, companies prioritizing sustainability are more resilient during crises, generate more consistent revenue over time, and experience less volatility in share prices. Nidumolu et al. (2009) outline that sustainable innovation lowers a company's costs, allows it to generate additional revenues from better products, and enables it to create new businesses for long-term organizational reliability. This alignment with consumer values enhances market position and strengthens the organization's long-term viability.

From an employee perspective, sustainable innovation fosters a shared value system that can significantly boost job satisfaction and performance. This alignment with corporate values, as highlighted by Deloitte's research on employee value propositions and human sustainability (Fisher et al., 2024), leads to higher employee retention and reduces talent outflow. Employees who identify with their company's commitment to sustainability are more engaged, innovative, and likely to exceed their job requirements.

Additionally, on the customer level, businesses committed to sustainability tend to produce more impactful and meaningful innovations. Sustainable innovation plays a mediating role in the process, linking Leadership 5.0 and organizational reliability. Recognizing the role of civil society, social entrepreneurs, volunteers, and other stakeholders in shaping impactful economic and social changes (OECD, 2022; Chala et al., 2023) by adopting a broader perspective that incorporates diverse viewpoints, Leadership 5.0 in such organizations fosters an environment of collaboration and knowledge sharing, leading to more robust and innovative solutions. Sustainable innovation thus enhances an organization's ability to meet customer needs and expectations, further strengthening its reliability and competitive edge.

2.3.4.1. Influence of Leadership 5.0 on Organizational Reliability through EDCs, Intrapreneurship, and sustainable innovation

As previously discussed, Leadership 5.0 fosters EDCs, which enable intrapreneurship by creating an environment where employees are empowered to innovate and take

initiative. Intrapreneurial activities, in turn, drive sustainable innovation by promoting the development of solutions that align organizational goals with environmental and social responsibilities. This pathway demonstrates that Leadership 5.0 indirectly enhances organizational reliability by nurturing EDCs, fostering intrapreneurship, and ultimately driving sustainable innovation.

Hence, EDCs, by fostering intrapreneurship, indirectly influence sustainable innovation. Organizations can enhance and fine-tune their innovative capabilities through dynamic capabilities, as noted by Lisboa et al. (2011). Employees' intrapreneurship is highly connected with their sensitivity to a dynamic environment and continuous voluntary searching and sharing of information (Park et al., 2014). The obtained information is further transmitted to facilitate decisions related to managerial and operational innovations (Kim and Rhee, 2011).

The mediating role of EDC facilitates the impact of Leadership 5.0 on sustainable innovation. This mediation ultimately enhances organizational reliability by aligning innovative efforts with strategic and sustainability goals. Research conducted by Chatman et al. (2014) provides a clear positive link between the culture of adaptability and organizational reliability in terms of its performance, leading to increased revenue for high-tech companies. These companies develop stronger business models, optimize processes, and tap into new market segments, all while responding to consumer demand for sustainable products and services.

Makkonen et al. (2014) further emphasized that dynamic capabilities and innovation contribute to an organization's competitive advantage and improve its evolutionary fitness, enabling it to adapt and thrive in changing environments. EDCs, in turn, make employees more comfortable acting in an entrepreneurial way. Employees feel safe and confident when coping with ambiguity and uncertainty and successfully spot opportunities while maintaining ethical and sustainable thinking. Continuous learning, individual and collaborative problem-solving, and the ability to adapt to changes allow them to take risks in suggesting creative decisions and mobilize various resources, thus demonstrating a high level of intrapreneurship. These skills, combined with a global vision, self-awareness, self-efficiency, and financial and economic literacy, provide a perfect ground for either a bottom-up initiated sustainable innovation or comprehensive support of those introduced by the leadership. Intrapreneurial employees identify opportunities and threats, adapt their actions, and drive innovations, enhancing the ability of the organization to stay competitive and reliable (Morais et al., 2021). Unlike traditional entrepreneurship, which is usually independent, intrapreneurship is embedded within the organizational framework, allowing employees to

leverage company resources to initiate improvements and innovations that benefit the entire organization (Berzin et al., 2016).

Thus, sustainable innovation amplifies the combined mediating effects of EDCs and intrapreneurship in translating Leadership 5.0 into enhanced organizational reliability and allows us to formulate the following hypothesis:

H3e: Sustainable innovation influenced by Leadership 5.0, EDCs, and Intrapreneurship has a positive direct effect on organizational reliability.

2.3.4.2. Influence of Leadership 5.0 on Organizational Reliability through IT adaptability, intrapreneurship, and sustainable innovation

As previously discussed, Leadership 5.0 promotes IT adaptability, which empowers employees to leverage digital tools for innovation and adaptability. IT-enabled intrapreneurship, in turn, drives sustainable innovation by developing solutions that align with environmental and social sustainability goals. This pathway demonstrates that Leadership 5.0 indirectly enhances organizational reliability through IT adaptability, intrapreneurship, and sustainable innovation.

By providing an adequate technological environment, IT adaptability demonstrates influence on sustainable innovation through the mediating role of intrapreneurship. Successfully implementing innovations within Industry 5.0 requires synergies between technology and human creativity and problem-solving skills. Employees' intrapreneurship competencies are needed to develop solutions that will ensure the alignment of sustainable innovations with the pressing environmental challenges, organizations' IT capabilities, and organizational reliability. IT adaptability is critical for organizations aiming to balance technological progress with environmental and social responsibilities within the context of Industry 5.0. Such organization prioritizes human-centric and sustainable solutions, and IT adaptability is a crucial facilitator of these goals. Adaptable IT systems create conditions for proactive initiatives and innovations that can integrate emerging technologies such as renewable energy solutions, circular economy platforms, environmentally sustainable computing, or advanced data analytics for sustainability metrics (Pazienza et al., 2024; Machado and Carvalho, 2023). Sustainable innovation requires organizations to continuously adjust and innovate in response to evolving environmental and market demands, therefore requiring IT systems to be adaptable to possible change (Toh, 2024).

IT adaptability is also a mediator, linking Leadership 5.0 and sustainable innovation and enhancing the role of the latter in ensuring organizational reliability. For a suc-

cessful sustainable innovation, IT adaptability is meant to be incorporated into the company's processes and support leadership toward organizational reliability. Guggenberger (2023) outlines that, for a responsible leader, introducing agility and adaptability is crucial for operating in a fast-moving environment. Within Industry 5.0, organizations with a Leadership 5.0 approach, prioritizing sustainability, technological adaptability, and cross-industry collaboration, can more readily experiment with and implement sustainable practices when embedding adaptability into their IT infrastructure. For example, a company with an adaptable IT system may integrate real-time data analytics to monitor its carbon footprint or optimize supply chains for greater efficiency and reduced waste. Such innovations will, in turn, contribute to organizational reliability by positively affecting its financial, social, and environmental results (Aguilera-Caracuel and Ortiz-de-Mandojana, 2013).

In this context, sustainable innovations further strengthen the mediating roles of IT adaptability and entrepreneurship in channeling Leadership 5.0 into enhanced organizational reliability. Thus, all the abovementioned factors allow us to formulate the following hypothesis:

H3f: Sustainable innovation influenced by Leadership 5.0, IT adaptability, and intrapreneurship have a positive direct effect on organizational reliability.

2.3.5. Indirect dynamic influence of Leadership 5.0 on Organizational Reliability

Dynamic approach to Leadership 5.0 influence on organizational reliability shows a dynamic, capability-building pathway. By fostering EDCs and IT adaptability, it equips organizations with the flexibility and resilience needed to respond to complex challenges. These capabilities drive intrapreneurship, encouraging employees to proactively generate and implement new ideas. In turn, intrapreneurial initiatives stimulate sustainable innovation, ensuring that organizational development aligns with long-term adaptability and responsibility. Through this chain of reinforcement, Leadership 5.0 dynamically enhances the organization's ability to maintain reliability, even under conditions of uncertainty and continuous change. Therefore, based on all the above, the following general hypothesis concerning dynamic mechanism of Leadership 5.0 influence on organizational reliability can be formulated (see Fig. 2.2):

H3: Leadership 5.0 influences organizational reliability through EDC, IT adaptability, intrapreneurship, and sustainable innovation.

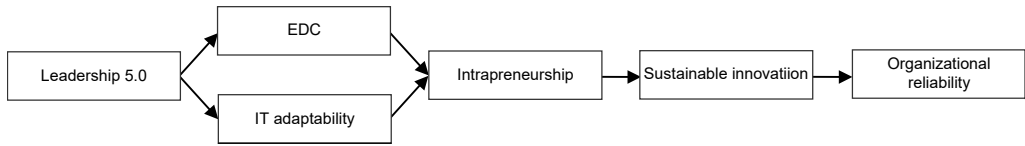


Figure 2.2. The model of Leadership 5.0 influence on organizational reliability
– dynamic approach. Source: own work

3. Empirical verification of Leadership 5.0 concept

The empirical verification of Leadership 5.0 concept was performed in three stages. First stage concerned the verification of Leadership 5.0 construct itself – using exploratory and confirmatory factor analysis. Second stage concerned the verification of the model of Leadership 5.0 static influence of organizational reliability. Third stage concerned the verification of the model of Leadership 5.0 dynamic influence of organizational reliability. Research methodology is presented in Figure 3.1.

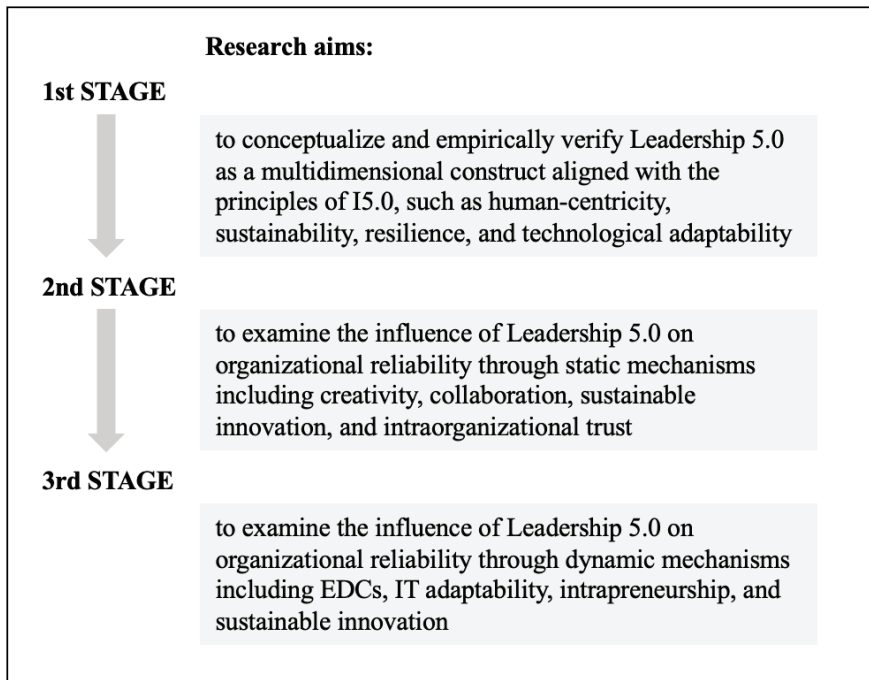


Figure 3.1. Research methodology. Source: own work

3.1. Research methodology

The theoretical models of hypotheses were validated through empirical research carried out in two stages to analyze and verify hypotheses related to leadership for Industry 5.0 and its impact on organizational reliability. The initial stage was a pilot study designed to validate the measurement tool, followed by the main research phase. The primary research instrument was a questionnaire that included a newly developed measurement scale for Leadership 5.0, along with previously validated scales for various variables included in the models and control variables.

Top-level managers from organizations in Poland completed the questionnaire, with each manager providing a single response per organization. Each of them had an extensive understanding of organizational operations. The first stage aimed to verify the quality of the questionnaire and included all proposed measurement scales. It involved 25 purposefully selected competent judges, specifically top-level managers, whose feedback led to revising several questions for clarity and comprehension. The second stage, conducted in the first quarter of 2024, concentrated on analyzing and verifying the proposed hypotheses.

3.2. Research sample

The empirical research was conducted using the Computer-Assisted Web Interview (CAWI) method, targeting a purposively selected sample of organizations in Poland. The study gathered responses from 462 organizations, with questionnaires filled in by top-level managers from pre-purchased respondent panels. Tables 4.1 and 4.2 provide a detailed breakdown of the sample, showing a diverse representation of organizations of varying sizes, industries, and levels of technological advancement, which is essential for the analyzed model.

Although the sample selection was not representative, the diversity of the organizations involved allows for formulating meaningful conclusions. The inclusion of organizations from different sectors enhances the robustness of the findings. Furthermore, the Kaiser–Meyer–Olkin (KMO) index was calculated for each variable and the overall model to ensure that the sample size and diversity were adequate for the intended statistical analyses.

Table 4.1. Sample description – size of organization

Size of employment	Number of organizations
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 work.

Table 4.2. Sample description – technology and industry

		Technological advancement			Total
		Industry 4.0	Industry 5.0	Other	
Source of revenue	Production	46	62	14	122
	Trade	15	30	9	54
	Services	46	126	36	208
	High-tech	13	17	7	37
	Other	3	16	16	35
Total		123	251	82	456

Source: own work.

3.3. 1st stage: Verification of Leadership 5.0 construct

To verify the hypotheses, and validate the construct, the variable Leadership 5.0 was introduced. The following 1-order latent variables which shaped it were included in the study: Visionary, Open-Mindedness, Empathy and emotional intelligence, Lifelong Learning, Global Mindset, Feedback-Seeking and Openness to Criticism, Data-Driven Decision Making, Supporting and Enhancing Employee Creativity, Promoting Diversity and Inclusivity, Supporting Continuous Learning and Development, Fostering Teamwork Cohesion, Empowering Employees through Autonomy, Demonstrating Responsible Leadership, Open Communication, Fostering Fair Systems, Committing to Sustainability, Technological Adaptability, Facilitating Collaboration Across Industries – each of them was measured based on a 5-point Likert scale, based on one or several items (see Appendix A).

3.3.1. Factor Analysis research results – Leadership 5.0

The Leadership 5.0 measurement scale was verified using Exploratory Factor Analysis (EFA) conducted in IBM SPSS Statistics and Confirmatory Factor Analysis using IBM SPSS AMOS. The initial (and final) measurement scale consisted of 39 items, including 14 items for leader's traits, 17 items for behavior towards employees, and 7 items for behaviors toward organization. In the first step, the *KMO* factor value was calculated sample adequacy. *KMO* was equal 0.975, which is way above 0.5 (Kaiser, 1974), confirming that the sample size was more than sufficient for the analysis. Next, the Bartlett's test of sphericity value was conducted, which should yield a probability score of less than 0.05 to conduct exploratory and confirmatory factor analysis (Hadi et al., 2016). The result of the Bartlett's sphericity test is equal to 11 289.454 (*df* 741, $p < 0.001$), which confirms that there is a significant correlation within the data and that it is sufficient for conducting a factor analysis.

The EFA resulted in a three-factor solution. First factor – leader's traits, in which 14 items explained a total of 62.829% of the variance for all items included in the measurement scale ($AVE = 0.628$). The component loads for all items of the measurement scale took on values above 0.6, which was set as the threshold for including items in the measurement scale. The component matrix for Leadership 5.0 (leader's traits) factor is shown in Table 4.3.

Table 4.3. Items loadings – leader's traits

Item	Factor loadings
<i>Visionary</i>	0.783
<i>Open-Mindedness</i>	0.705
<i>Empathy and emotional intelligence</i>	0.779
<i>Lifelong Learning</i>	0.738
<i>Global Mindset</i>	0.891
<i>Feedback-Seeking and Openness to Criticism</i>	0.849
<i>Data-driven decisions</i>	0.787

Source: own work.

Second factor – behavior toward employees, in which 17 items explained a total of 76.150% of the variance for all items included in the measurement scale ($AVE = 0.761$). The component loads for all items of the measurement scale took on values above 0.6, which was set as the threshold for including items in the measurement scale.

The component matrix for Leadership 5.0 (behavior toward employees) factor is shown in Table 4.4.

Table 4.4. Items loadings – behavior toward employees

Item	Factor loadings
<i>Supporting and Enhancing Employee Creativity</i>	0.831
<i>Promoting Diversity and Inclusivity</i>	0.840
<i>Supporting Continues Learning and Development</i>	0.922
<i>Fostering Teamwork Cohesion</i>	0.848
<i>Empowering Employees through Autonomy</i>	0.908
<i>Demonstrating Responsible Leadership</i>	0.882

Source: own work.

Third factor – behavior toward organization, in which 7 items explained a total of 65.574% of the variance for all items included in the measurement scale ($AVE = 0.655$). The component loads for all items of the measurement scale took on values above 0.6, which was set as the threshold for including items in the measurement scale. The component matrix for Leadership 5.0 (behavior toward organization) factor is shown in Table 4.5.

Table 4.5. Items loadings – behavior toward organization

Item	Factor loadings
<i>Open Communication</i>	0.854
<i>Fostering Fair Systems</i>	0.849
<i>Committing to Sustainability</i>	0.735
<i>Technological Adaptability</i>	0.800
<i>Facilitating Collaboration Across Industries</i>	0.806
<i>Demonstrating Responsible Leadership</i>	0.854

Source: own work.

Hence, 3 latent variables were explaining 88.336% of the variance for second-order latent variable: Leadership 5.0 ($AVE = 0.883$). The analysis of a scree plot confirmed that one factor solution should be obtained. Factor loadings for all latent variables were above 0.9, which was established to be above a threshold for including items into the measurement scale (which was 0.6). Described results are presented in Table 4.6.

Table 4.6. Variables overview

Variable name	Number of items	AVE	K-M-O	Alpha Cronbach	N
Leadership 5.0	39 (14, 17, 7)	0.883	0.975	0.973	423

Source: own work.

Confirmatory factor analysis for the identified 39 items disseminated across variables shaping three-factor solution was next performed. The resulting model was confirmed to be statistically significant and a good fit, as evidenced by the statistics $CFI = 0.923$, $TLI = 0.957$ (both should remain above 0.9 according to Hu and Bentler (1999)) and $RMSEA = 0.081$ (value should remain below 0.2 according to Hopwood and Donnellan (2010)).

Therefore, the performed test results allow to accept the proposed hypothesis H0, stating that Leadership 5.0 is a multi-dimensional construct that is characterized by Industry 5.0 specific leaders' traits, behaviors towards employees, behaviors towards the organization.

3.3.2. Discussion on 1st stage of research

Leadership 5.0 is a concept that blends the technological advancements of Industry 4.0 influenced by the creativity-centered approach of Society 5.0, underlining that technological progress should commit to human-centric values (Huang et al., 2022). Unlike various other leadership styles, which often focus on efficiency and productivity, Leadership 5.0 emphasizes the harmonious integration of all critical for Industry 5.0 elements: human-centricity, sustainability and resilience (Huang et al., 2022; Alves et al., 2023). In this context, Leadership 5.0 can be understood as a leadership style that combines individual characteristics of leaders, their behavior towards employees, and their approach to the organization, with the goal of harmonizing technological advancements with the well-being of employees and society. This approach aligns with the Hersey-Blanchard Model (Hersey and Blanchard, 1969), which posits that leadership styles should adapt to the maturity and competence of followers. Leadership 5.0 also reflects Fiedler's Contingency Theory (Fiedler, 1967; Peters et al., 1985), which asserts that a leader's effectiveness is contingent upon both their style (task-oriented or relationship-oriented) and the extent to which the situation provides them with control and influence.

In the current study, the findings confirmed that Leadership 5.0 is indeed a three-factor model. The first factor, individual traits, highlights the importance of a leader's internal characteristics in fostering innovation, guiding technological adaptability, and ensuring human-centric values in alignment with Industry 5.0 principles. Key traits such as visionary thinking, open-mindedness, and empathy combined with emotional intelligence emerged as essential to creating a balance between technological progress and human well-being (in line with Breque et al., 2021). These traits enable leaders to anticipate future trends and navigate the rapidly evolving industrial landscape, while simultaneously maintaining a focus on employee well-being and societal impact. In line with the transformational leadership approach, lifelong learning and a global mindset are also critical for ensuring that leaders remain adaptable, continuously acquire new knowledge, and understand the broader global perspective needed for Industry 5.0 (in line with Beechler and Javidan, 2007; Smith and Parsell, 2023).

The second factor, leadership behaviors towards employees, emphasizes the ways in which Leadership 5.0 leaders interact with and support their teams. Supporting creativity and innovation, promoting diversity and inclusivity, and fostering continuous learning are identified as vital behaviors that enhance employee engagement, job satisfaction, and performance (in line with Jaiswal and Dhar, 2015; Javed et al., 2021). Moreover, empowering employees through autonomy fosters intrinsic motivation and problem-solving abilities, which are crucial for organizations aiming to stay competitive in Industry 5.0 (in line with Alves et al., 2023). The emphasis on teamwork cohesion and building trust through open communication further underlines the role of Leadership 5.0 leaders in cultivating collaborative, high-performing teams that can effectively tackle the complex challenges of Industry 5.0 (in line with Griffin et al., 2001).

Finally, the third factor, leadership behaviors towards the organization, incorporates strategic, systemic, and value-driven behaviors that ensure organizational resilience in the face of technological disruption and global challenges. This dimension includes data-driven decision-making, where leaders use data to inform strategic choices, optimize processes, and foster innovation (in line with Salvetti and Bertagni, 2020). Additionally, responsible leadership and commitment to sustainability are vital to aligning organizational goals with the broader societal and environmental objectives of Industry 5.0 (in line with Fortuna and Paesano, 2022). Leadership 5.0 leaders demonstrate technological adaptability, ensuring that human potential is augmented rather than diminished by technological advancements, and facilitate cross-sector collaboration, promoting synergies across industries (in line with Olsson et al., 2024).

The research contributes to existing leadership literature by introducing Leadership 5.0, a concept that addresses the theoretical and practical gaps in leadership styles required for Industry 5.0. Building on foundational leadership theories (e.g., Kerr et al., 1974; Fiedler, 1967; Hersey and Blanchard, 1969), Leadership 5.0 integrates human-centric values, sustainability, and social fairness with advanced technological paradigms. It extends transformational leadership (Bass, 1985; Bass and Riggio, 2006) by balancing technological integration with human creativity and intrinsic values, fostering a harmonic coexistence. The model incorporates inclusive leadership by leveraging diversity for technological and creative progress (Javed et al., 2021), elements of servant leadership with a focus on ethical technology use (Liden et al., 2008), and authentic leadership principles by aligning integrity with a forward-looking, human-centric vision (Avolio and Gardner, 2005). Leadership 5.0 also adapts situational and contingency leadership theories to dynamic organizational needs, emphasizing the necessity of tailoring leadership to the evolving context of Industry 5.0. It remains a clear contribution the field of leadership in the situational theory context. It deepens the Hersey-Blanchard Situational Leadership Model (Hersey and Blanchard 1969) approach, showing the need to not only adjust to competence of the followers but also enhance them in the line with Industry 5.0. It also confirms the assumptions of Fiedler's Contingency Theory (Fiedler, 1967), taking it a step further showing its validity for Industry 5.0. It also contributes to change management theory by aligning leadership style with the strategic goals of Industry 5.0. It emphasizes a shift toward human-centric, value-driven leadership to guide organizations through technological and organizational transitions while upholding sustainability and resilience. By integrating human values with technology and ensuring long-term sustainability, Leadership 5.0 provides a framework for managing change effectively in the evolving landscape of Industry 5.0.

3.4. Other variables description and measurement scales analysis

The following variables were introduced to verify the hypotheses:

- **Leadership 5.0 (L5.0)** – variable based on 39 items assessed on the 5-point Likert scale concerning various aspects of leadership (leaders traits, behaviors

towards employees, behaviors towards the organization, and specific behaviors enabling Industry 5.0) [Anonymized].

- **Sustainable Innovation (Sinn)** – variable based on 13 items assessed on the 5-point Likert scale concerning different elements shaping sustainable innovations concerning three dimensions: economic, environmental, and social.
- **Intraorganizational trust (Trust)** is the variable based on three items assessed on the 5-point Likert scale concerning trust within the organization and trust of employees towards the organization.
- **Creativity (Cre)** is the variable based on three items assessed on the 5-point Likert scale concerning various aspects of creative problem-solving and offering solutions within the organization.
- **Integration (Intg)** is the variable based on two items assessed on the 5-point Likert scale concerning cooperation between departments within the organization.
- **EDCs (EDCs)** – variable based on five items assessed on the 5-point Likert scale concerning employees and their ability to identify and react to changes occurring within and outside the organization.
- **IT Adaptability (ITA)** – variable based on two items assessed on the 5-point Likert scale concerning IT support for the dynamic capabilities of the organization.
- **Intrapreneurship (Intr)** – variable based on three items assessed on the 5-point Likert scale concerning employees' abilities to engage in entrepreneurial activities.
- **Organizational Reliability (OrgRel)** – variable based on 15 items assessed on the 5-point Likert scale concerning both organizational performance and organizational errors.
- **Industry 5.0 (I5.0)** is based on five items, also assessed on the 5-point Likert scale, and it concerns the level of implementation of the Industry 5.0 concept within the organization. It was used for multigroup path analysis to split the sample into two groups of organizations (with a low level of Industry 5.0 implementation [below 3] and a high level of Industry 5.0 implementation [above and equal to 3]).

To conduct statistical analyses and verify the proposed hypotheses, all measurement scales used in the study were rigorously analyzed and validated. Initially, it was confirmed that the collected data exhibited normal distribution. Subsequently, the measurement scale analysis was performed using three statistical tests. Cronbach's Alpha Analysis was conducted to verify the coherence and reliability of the measurement scale. A Cronbach's Alpha value above 0.7 indicates average reliability, while values above 0.8 are considered more than satisfactory (Drost, 2011). This analysis was

performed using IBM SPSS. Confirmatory Factor Analysis (CFA) was utilized to verify the coherence and internal consistency of the measurement scale. The Average Variance Extracted (AVE) value, indicating the percentage of variance explained by the latent variable, should exceed 0.5. Model fit statistics were evaluated against the following criteria: $X^2/df < 5.000$, $TLI > 0.800$, $CFI > 0.800$, $GFI > 0.800$, and $RMSEA < 0.2$ (Hopwood and Donnellan, 2010). This analysis was also performed using IBM SPSS. The Kaiser–Meyer–Olkin (KMO) test was performed to assess the adequacy of the sample size for analysis using the measurement scale. KMO values above 0.5 are deemed sufficient for further analysis (Field, 2000; Kaiser, 1974). These rigorous statistical tests ensured the reliability and validity of the measurement scales, enabling robust verification of the proposed hypotheses.

The results of all the tests conducted are presented in Table 4.7. The findings confirm that the selected measurement scales are internally consistent, reliable, and coherent, making them suitable for further analysis. Additionally, discriminant validity was evaluated to ensure that all latent variables representing distinct theoretical constructs are statistically distinct. The Heterotrait-Monotrait Ratio (HTMT) tests yielded values below 0.65 (Hamid et al., 2017), indicating that the chosen variables are appropriate for subsequent analyses, including correlation, regression, and path analysis. Almost all variables were first-order latent variables. Only organizational reliability was proven to be a second-order latent variable shaped by organizational performance and organizational errors.

Table 4.7. Variables Overview

Variable name	Variable name	Number of items	AVE	K–M–O	Alpha Cronbach	N
Leadership 5.0	L5.0	39	0.598	0.975	0.973	423
Sustainable Innovation	Sinn	13	0.547	0.962	0.931	445
EDCs	EDCs	5	0.531	0.811	0.778	455
ITA	ITA	2	0.599	0.808	0.801	461
Intrapreneurship	Intr	3	0.667	0.690	0.751	459
Trust	Trust	3	0.680	0.692	0.765	455
Creativity	Cre	3	0.691	0.691	0.777	461
Integration	Intg	2	0.696	0.500	0.562	459
Organizational Reliability	OrgRel	15	0.593	0.917	0.864	443

Source: own work.

Common method bias arises when data for both independent and dependent variables are collected from the same source and within the same measurement context, as is the case when using a questionnaire as a measurement tool. In management sciences, Harman's Single-Factor Test is commonly employed to determine the presence of common method bias in a given sample (Aguirre et al., 2019). This test assesses whether a single factor or one general factor accounts for the majority (>50%) of the covariance among the variables. If a single factor predominates, common method bias is indicated.

In this study, Harman's Single-Factor Test was conducted using IBM SPSS through the Dimension Reduction Procedure. By performing a Confirmatory Factor Analysis with the number of factors fixed at one, it was found that the percentage of variance explained by this single factor was 32.7%. This result indicates that common method bias is not present in the sample.

3.5. 2nd stage: Leadership 5.0 influence on Organizational Reliability – static approach

The second stage of research aimed at establishing a mechanism of Leadership 5.0 influence on organizational reliability in a static approach was conducted based on the path analysis.

The analysis commenced with a linear regression model calculated in IBM SPSS to determine whether the proposed independent variable, Leadership 5.0, has a statistically significant impact on organizational reliability while controlling for other factors typically influencing such reliability. Additionally, the analysis verified the presence of multicollinearity among the variables within the sample. Multicollinearity occurs when an independent variable in the model exhibits a significant correlation with other independent variables, precluding the use of path analysis. This is assessed using the Variance Inflation Factor (*VIF*), with values below 5.0 indicating no multicollinearity issue, allowing path analysis to proceed (Midi and Bagheri, 2010).

The obtained model was statistically significant, with $R^2 = 0.532$ and $F(12,374) = 37.624$, $p < 0,001$. The statistics concerning each variable are given in Table 4.8.

The results of the linear regression analysis unequivocally confirm that Leadership 5.0 is a statistically significant component of the model, which incorporates

control variables related to Leavitt's model that typically influence organizational reliability. Additionally, the multicollinearity test, assessed using the Variance Inflation Factor (*VIF*), yielded values below 5.0 for all variables. Consequently, the sample supports the use of statistical reasoning based on path analysis with the proposed variables.

Table 4.8. Regression analysis

Model	Unstand.		Stand.	<i>t</i>	<i>p</i>	<i>VIF</i>
	<i>B</i>	<i>SE</i>	Beta			
(Const)	0.648	0.177		3.663	< .001	
L5.0	0.162	0.064	0.153	2.523	0.012	3.022
CV1	0.063	0.034	0.086	1.883	0.060	1.713
CV2	-0.024	0.026	-0.037	-0.893	0.372	1.401
CV3	-0.026	0.032	-0.035	-0.811	0.418	1.563
CV4	0.004	0.031	0.005	0.122	0.903	1.480
CV5	0.001	0.033	0.001	0.019	0.985	1.658
CV6	0.034	0.031	0.049	1.123	0.262	1.554
CV7	0.020	0.035	0.023	0.579	0.563	1.347

Source: own work.

Based on the initial analysis, path analysis was conducted using SPSS AMOS. This analysis identified a statistically significant and well-fitted model. Baseline comparison indicated that the characteristics of the unconstrained model fell within acceptable margins for statistical reasoning. A comprehensive assessment of model fit was performed using the Comparative Fit Index (*CFI*), Tucker-Lewis Index (*TLI*), and Root Mean Square Error of Approximation (*RMSEA*). According to Hu and Bentler (1999), *CFI* and *TLI* values should exceed 0.9, while Hopwood and Donnellan (2010) suggest that *RMSEA* should remain below 0.2 in social sciences.

The goodness of fit indices was excellent: *CFI* = 0.939 and *TLI* = 0.817. The *RMSEA* value was 0.153, which is acceptable in this context, with *PCLOSE* = 0.001. The model's statistical significance was also assessed, yielding Chi-squared ($\chi^2(7) = 82.753$); $p = 0.001$. This indicates that the model is well-fitted and statistically significant, providing a sound basis for statistical reasoning.

An overview of the model obtained for the given sample is presented in Table 4.9, including total and indirect effects within the model (Tables 4.10–4.12).

Table 4.9. Regression Weights

			Estimate	S.E.	C.R.	P
Intg	<---	L5.0	0.647	0.047	13.853	***
Cre	<---	L5.0	0.755	0.045	16.888	***
SInn	<---	L5.0	0.508	0.051	9.875	***
Trust	<---	L5.0	0.817	0.039	20.803	***
SInn	<---	Intg	0.108	0.036	3.011	0.003
SInn	<---	Cre	0.195	0.037	5.196	***
OrgRel	<---	Trust	0.022	0.040	0.566	0.571
OrgRel	<---	SInn	0.598	0.043	13.752	***

Source: own work.

Table 4.10. Total Effects

	L5.0	Cre	Intg	SInn	Trust
Cre	0.755	0.000	0.000	0.000	0.000
Integration	0.647	0.000	0.000	0.000	0.000
SInn	0.724	0.195	0.108	0.000	0.000
Trust	0.817	0.000	0.000	0.000	0.000
OrgRel	0.415	0.116	0.065	0.598	0.022

Source: own work.

Table 4.11. Direct Effects

	L5.0	Cre	Intg	SInn	Trust
Cre	0.755	0.000	0.000	0.000	0.000
Intg	0.647	0.000	0.000	0.000	0.000
SInn	0.508	0.195	0.108	0.000	0.000
Trust	0.817	0.000	0.000	0.000	0.000
OrgRel	0.000	0.000	0.000	0.598	0.022

Source: own work.

Table 4.12. Indirect Effects

	L5.0	Cre	Intg	SInn	Trust
Cre	0.000	0.000	0.000	0.000	0.000
Intg	0.000	0.000	0.000	0.000	0.000
SInn	0.217	0.000	0.000	0.000	0.000
Trust	0.000	0.000	0.000	0.000	0.000
OrgRel	0.415	0.116	0.065	0.000	0.000

Source: own work.

Table 4.9 shows that all relations within the model are statistically significant. The relation between leadership for Industry 5.0 and trust is the strongest ($B = 0.817$), which shows the importance of that influence for boosting organizational reliability. Moreover, all the statistically significant relations within the model are characterized by estimates above 0 ($B > 0.0$), meaning that authentic leadership positively influences organizational reliability through a series of mediators tested in the path analysis. Besides, Table 4.12 shows that mediation occurs within the proposed path model, as the indirect effects occur in all established relations. Such results allow to accept the H1 and H2 hypothesis (with detailed hypotheses H2a–H2d) stating that Leadership 5.0 influences organizational reliability through creativity, integration, sustainable innovation and intraorganizational trust in organizations implementing the Industry 5.0 framework.

Furthermore, in order to verify that the relations within the obtained model are indeed stronger for organizations characterized by a higher level of implementation of Industry 5.0 framework, the multigroup path analysis was performed using IBM SPSS AMOS. The goodness of fit indices was excellent: $CFI = 0.912$ and $TLI = 0.888$. The $RMSEA$ value was 0.141, which is acceptable in this context, with $PCLOSE = 0.001$. For both models, all relations within the model were statistically significant. However, the strength of relations obtained for organizations with higher levels of Industry 5.0 framework implementation was higher than those obtained for organizations with lower levels of Industry 5.0 framework implementation. Further confirms that Leadership 5.0 influences organizational reliability through creativity, integration, sustainable innovation and intraorganizational trust in organizations operating under the Industry 5.0 framework, and the strength of such influence rises together with the level of implementation of the Industry 5.0 framework.

3.5.1. Discussion on 2nd stage of research

Empirical results show that Leadership 5.0 positively influences organizational reliability through intraorganizational trust, supporting H1. This is consistent with previous research on the impact of leadership on intraorganizational trust, extending its implications in the context of Industry 5.0. Grudzewski et al. (2008) emphasize the role of a culture of trust in an organization. A culture of trust is built through certain types of leadership. Such leadership is expressed, among other things, in the freedom to express one's judgments and opinions, even those that contradict the vision of superiors, the willingness to present one's own ideas, and honesty in dealing with superiors,

which are also expressions of intraorganizational trust (Bieńkowska et al., 2018). Given the research results, it should be assumed that the Leadership 5.0 concept supports building a culture of trust in the organization, which translates into increased intraorganizational trust. Employees feel safe, which influences building a positive cooperation climate based on trust (Jurek, 2019). This, in turn, strengthens organizational reliability.

According to the suggested model, there is clear evidence of the positive effect Leadership 5.0 has on organizational reliability through sustainable innovation, hence supporting H2. These findings provide a solid ground for proving the complex and multidimensional role of both Leadership 5.0 and sustainable innovation on organizational performance, adding to the scope of previous studies. To date, very little research focuses on sustainable innovation's impact on organizational reliability, particularly in terms of combining economic, environmental, and social dimensions. However, our findings agree with the results of prior empirical research on the separate aspects of Leadership 5.0, sustainable innovation or organizational reliability. Introducing environmental commitments into the innovation process is seen to be a given competitive advantage and performance (Gomez-Conde et al., 2019; Shrivastava, 1995). However, the evidence of sustainable innovation being beneficial in terms of organizational economic performance is controversial (Cillo et al., 2019). Vanclay (2004) claims neutral or positive relations. Kneipp et al. (2019) spotlight that adopting sustainable innovation leads to superior organizational performance through collaboration with stakeholders, including sustainable suppliers, practices to reduce emissions, and product-service systems that create alternatives to replace products with services. Others (DiVito and Bohnsack, 2017; Kuckertz and Wagner, 2010) outline that companies doing sustainable innovation have to accept lower profits.

The absence of a single verified scale for measuring the impact of sustainable innovation on the ability to perform effectively might be the reason for such inconsistencies. When non-financial dimensions are included to measure organizational performance, sustainable innovation proves to have a positive impact on the organization's effectiveness (Afeltra et al., 2022), with societal aspects being more relevant than economic and environmental. Asadi et al. (2020) also proved significant paired relations between green innovations and firms' social, environmental, and economic performance. Additionally the authors showed that leadership, which prioritises green transformations, enables workers to create eco-friendly products and ensures the firm's ability to attain sustainable growth. In turn, Sawaeen and Ali (2020) proved the influence of the entrepreneurial aspect of Leadership 5.0, having determined a significant

mediating role of innovation capacity between entrepreneurial leadership and organizational performance. The crisis leadership of Kurniawan et al. (2024) obtained characteristics of Leadership 5.0 (taking criticism and feedback well, being eager to learn, promoting open communication and data-driven decisions). It turned out to positively influence sustainable performance defined by all three components (economic, social, and environmental) directly and through the mediating role of innovation capability.

The current study confirms that Leadership 5.0 positively influences sustainable innovation through creativity, thus supporting H3. This aligns with previous studies on leadership's impact on creativity and innovation, extending their implications within the Industry 5.0 context. The meta-analytic review by Lee et al. (2020) supports the view that leadership styles promoting intellectual stimulation and providing a vision are particularly effective in fostering creativity. Specifically, transformational leadership has a strong positive correlation with creative performance. Gumusluoglu and Ilsev (2009) found that transformational leadership positively impacts followers' creativity at the individual level and organizational innovation at the broader level. Khalili (2016) indicates that transformational leadership, coupled with a supportive climate for innovation, significantly enhances employees' creativity and leads to innovative outcomes. Other studies (e.g., Hughes et al., 2018; Roberson and Perry, 2021) also underline the importance of a supportive organizational climate in promoting creativity and innovation. Arici and Uysal (2022) further elaborate that green transformational leadership significantly affects green creativity and innovation, reinforcing the importance of leadership in driving sustainable innovation initiatives. Asadi et al. (2020) illustrated that green innovations, driven by leadership prioritising environmental sustainability, enhance social, environmental, and economic performance. This aligns with the notion that Leadership 5.0 can drive sustainable innovation through creative processes by embedding environmental and social considerations into its leadership approach.

The emphasis on human-centric values under Leadership 5.0 also aligns with the digital humanism concept proposed by Scuotto et al. (2023), highlighting the critical role of human skills and creativity in shaping technological development. Foerster-Metz et al. (2018) argue that the future workforce must adopt a connected mindset focused on innovation and creativity to navigate structural changes driven by technological advancements. Similarly, Bresciani et al. (2021) suggest that creativity acts as a catalyst for digital transformation, promoting both technological advancement and a culture of continuous innovation. According to Smuts and Van der Merwe (2022),

fostering qualities such as creativity and problem-solving and enhancing knowledge related to human and intellectual capital helps organizations secure future success. De Vasconcellos et al. (2021) found that investing in employee creativity enhances organizational performance, especially when this creativity boosts digital skills. This synergy helps organizations stay agile and adaptable in the fast-changing digital landscape. This perspective aligns with our findings, demonstrating how Leadership 5.0 leverages creativity to drive sustainable innovation, thus contributing to organizational reliability and resilience.

The study also confirms the positive influence of Leadership 5.0 on sustainable innovation through collaboration, supporting H4. This confirms that collaboration is crucial in the interconnected and collaborative framework of Industry 5.0, where synergy between diverse elements is necessary to achieve balanced and sustainable outcomes (Breque et al., 2021; Xu et al., 2021; Magni et al., 2024). Our results align with the studies indicating collaboration's positive impact on sustainable innovation development. Effective collaboration within and across organizational boundaries is essential for leveraging diverse perspectives and fostering innovation (Wolf and Erfurth, 2019; Smuts and Merwe, 2022; Gomathi et al., 2023). Sitaloppi and Ballardini (2023) highlight that sustainability transitions require new forms of systemic collaboration supported by proper regulatory structures. They emphasize the need for multi-stakeholder collaboration to achieve system-level sustainability improvements, which involves co-specialization and shared alignment structures among heterogeneous actors. Such systemic collaboration is crucial for developing sustainability-improving solutions that are beyond the capabilities of individual actors. Reficco et al. (2018) indicated that collaboration is one of the key enabling conditions within organizations that facilitate the overall impact of sustainable efforts.

Leadership 5.0's emphasis on collaboration addresses complex challenges and drives sustainable innovation (Leng et al., 2022; Ivanov, 2023). This approach aligns with the holistic perspective required for Industry 5.0, where diverse stakeholders are engaged in the innovation process, enhancing the organization's capacity to achieve sustainable outcomes (Papetti et al., 2020; Bednar et al., 2020). The collaborative efforts under Leadership 5.0 enhance the organization's adaptability and resilience, which are essential for sustainable innovation in the face of disruptions (Ivanov, 2023).

Furthermore, Bossink (2007) explores the effects of a manager's leadership style on sustainable, environment-friendly innovation processes. The research highlights that the exchange of knowledge and information within the organization is crucial for the success of these processes. This supports our findings that sustainable innovation is

not only technologically driven but also deeply rooted in human creativity and collaboration. By emphasizing human-centric values and fostering an environment that encourages both creativity and collaboration, Leadership 5.0 enables organizations to achieve sustainable innovation.

3.6. 3rd stage: Leadership 5.0 influence on Organizational Reliability – dynamic approach

Third stage of research concerned a path analysis, which was in this case conducted to establish how Leadership 5.0 influences organizational reliability in a dynamic approach. Path analysis was carried out using SPSS AMOS. This analysis revealed a statistically significant and well-fitting model. Baseline comparisons indicated that the characteristics of the unconstrained model fell within acceptable limits for statistical reasoning. A comprehensive assessment of model fit was conducted using the Comparative Fit Index (*CFI*) and Root Mean Square Error of Approximation (*RMSEA*). According to Hu and Bentler (1999), the *CFI* value should be above 0.85, while Hopwood and Donnellan (2010) suggest that *RMSEA* should be below 0.2 in social sciences. The *CFI* = 0,843 and the *RMSEA* = 0,141 are acceptable in this context, with *PCLOSE* = 0,001. The model's statistical significance was also evaluated, yielding Chi-squared ($\text{Chi}^2(9) = 249.436$); $p = 0,001$. These results indicate that the model is both well-fitting and statistically significant, providing a robust basis for further statistical reasoning.

An overview of the model obtained for the given sample is presented in Table 4.13, including total and indirect effects within the model, detailed in Tables 4.14–4.16.

Table 4.13. Regression Weights

			Estimate	S.E.	C.R.	P
EDCs	<---	L5.0	0.727	0.032	22.501	***
ITA	<---	L5.0	0.703	0.045	15.777	***
Intr	<---	EDCs	0.522	0.039	13.336	***
Intr	<---	ITA	0.287	0.033	8.670	***
SInn	<---	Intr	0.691	0.035	19.879	***
OrgRel	<---	SInn	0.582	0.038	15.407	***

Source: own work.

Table 4.14. Total Effects

	L5.0	ITA	EDCs	Intr	SInn
ITA	0.703	0.000	0.000	0.000	0.000
EDCs	0.727	0.000	0.000	0.000	0.000
Intr	0.581	0.287	0.522	0.000	0.000
SInn	0.402	0.198	0.361	0.691	0.000
OrgRel	0.234	0.116	0.210	0.402	0.582

Source: own work.

Table 4.15. Direct Effects

	L5.0	ITA	EDCs	Intr	SInn
ITA	0.703	0.000	0.000	0.000	0.000
EDCs	0.727	0.000	0.000	0.000	0.000
Intr	0.000	0.287	0.522	0.000	0.000
SInn	0.000	0.000	0.000	0.691	0.000
OrgRel	0.000	0.000	0.000	0.000	0.582

Source: own work.

Table 4.16. Indirect Effects

	L5.0	ITA	EDCs	Intr	SInn
ITA	0.000	0.000	0.000	0.000	0.000
EDCs	0.000	0.000	0.000	0.000	0.000
Intr	0.581	0.000	0.000	0.000	0.000
SInn	0.402	0.198	0.361	0.000	0.000
OrgRel	0.234	0.116	0.210	0.402	0.000

Source: own work.

Table 4.13 indicates that all relations within the model are statistically significant. The strongest relation is between Leadership 5.0 and EDCs ($B = 0,727$), highlighting the crucial role of this influence in enhancing organizational reliability. Additionally, all statistically significant relations in the model have positive estimates ($B > 0,0$), indicating that Leadership 5.0 positively impacts organizational reliability through a series of mediators examined in the path analysis. Furthermore, Table 4.16. demonstrates that mediation occurs within the proposed path model, as indirect effects are present in all established relationships. These findings support the acceptance of H3 (with detailed hypotheses H3a–H3f), which states that Leadership 5.0 influences organiza-

tional reliability through EDCs, IT adaptability, intrapreneurship, and sustainable innovations.

To confirm that the relationships within the model were stronger for organizations with a higher level of Industry 5.0 implementation, a multigroup path analysis was conducted using IBM SPSS AMOS. The model fit indices *CFI*, *TLI*, and *RMSEA* were acceptable, and the model was well-fitted. In both models, all relationships were statistically significant. However, the strength of the relationships was greater for organizations with higher Industry 5.0 implementation compared to those with lower levels. This finding further supports that Leadership 5.0 influences organizational reliability through EDCs, IT adaptability, intrapreneurship, and sustainable innovations, and the strength of this impact increases as the level of Industry 5.0 implementation rises.

3.6.1. Discussion on 3rd stage of research

The empirical analysis allowed us to prove that Leadership 5.0 has a positive influence on organizational reliability through EDCs, confirming H1. This allows us to fill the existing research gap and provides empirical evidence of the relationship between leadership, EDCs, and organizational reliability, where previously scholars anticipated and conceptualized their existence. The model provides evidence that by fostering EDCs through Leadership 5.0 practices, organizations will improve their organizational reliability, supporting the viewpoint of Chatterjee et al. (2022) on EDCs enhancement outcomes and Wang's argument on the role of dynamic capabilities in building a more resilient and adaptable organization (Wang et al., 2024a).

The model also confirms the positive influence of Leadership 5.0 on organizational reliability through IT adaptability. In the suggested model, IT systems prove to provide a positive influence on organizational reliability within changing conditions, as expected by Tworek (2023b). This effect is particularly evident when IT systems are effectively introduced and managed by Industry 5.0 leaders, who prioritize a strategic alignment with human-centric and sustainability goals (Patten et al., 2005; Kane et al., 2015). Based on the research results, it can additionally be assumed that adaptable IT systems support the implementation of the Leadership 5.0 approach by providing data and tools for timely data-driven (Stank and Lackey, 1997) and agile decision (Darvishmotevali and Ali, 2020; Wanasida et al., 2021)

The findings highlight the pivotal role of Leadership 5.0 in fostering intrapreneurial behavior and enhancing organizational reliability through the mediating effects of EDCs. Leadership 5.0, characterized by autonomy, inclusivity, and creativity, facilitates

an environment where employees are empowered to identify opportunities, adapt to changes, and implement innovative solutions, aligning with the demands of the Industry 5.0 context. EDCs facilitate this process by equipping employees with the sensitivity to recognize and respond to environmental shifts, enabling proactive problem-solving and continuous improvement. Our results also correspond with the findings of Wang et al. (2024b), who underscore the necessity for continuous learning and development within the organization. As employees engage in proactive learning, they enhance their skills and competencies, which are vital for navigating the complexities of digital transformation (Wang et al., 2024b), closely aligned with Industry 5.0. Intrapreneurial behaviors, as operational manifestations of EDCs, drive organizational reliability by enhancing innovation, resilience, and strategic adaptability. Employees with strong intrapreneurial skills help organizations capitalize on opportunities and mitigate risks, ensuring sustained competitiveness in dynamic markets. This underscores the importance of cultivating Leadership 5.0 practices and investing in developing EDCs to enable organizations to thrive in VUCA environments while leveraging Industry 5.0 opportunities.

The suggested model also demonstrates that Leadership 5.0 enhances organizational reliability by influencing IT adaptability and intrapreneurship. In the context of Industry 5.0, the above prerequisites enable seamless technological integration, agile decision-making, and proactive responses to challenges, forming a foundation for sustainable innovation. Leadership 5.0 fosters this adaptability by aligning technology with strategic goals and promoting a culture of innovation and empowerment.

IT adaptability and EDCs drive intrapreneurship by enabling employees to think creatively and mobilize resources to leverage technology for innovation, process improvement, and cross-industry collaboration. These intrapreneurial behaviors strengthen organizational resilience by addressing emerging opportunities and risks, ensuring stability in dynamic environments. This integrated approach is empirically proved and aligns with the Organizational Reliability Model (Bieńkowska et al., 2020), emphasizing the interdependence of technological and human adaptability for sustained performance.

3.7. Research overall discussion

3.7.1. 1st stage of research – Leadership 5.0

The first stage of study has successfully introduced and empirically verified the Leadership 5.0 concept, specifically designed to navigate the complexities of the Industry 5.0.

Developed through a comprehensive review of literature on Industry 5.0 and leadership theories, the Leadership 5.0 concept is a forward-looking approach tailored to meet the needs of modern organizations. It is built on three fundamental pillars: individual leader traits, behaviors towards employees, and behaviors towards the organization. This concept captures the essence of Leadership 5.0, which is crucial for success in Industry 5.0. The empirical study confirmed that the concept is internally coherent and has potential to enable organizations to excel in today's dynamic industrial landscape.

The Leadership 5.0 concept advances our understanding of how leadership can be restructured to drive organizational success through change in technologically advanced and human-centered work environments. It also provides a concrete concept for leaders aiming to foster sustainability and resilience within technology-driven environments, establishing a foundation for future theoretical and practical explorations in advanced industrial contexts. It constitutes a significant contribution to the management sciences, placing new concept in situational theories in the field of leadership, contributing in this way also to organization change management.

The study acknowledges limitations, including its focus on organizations from a single regional context, which may restrict generalizability, and the potential bias from self-reported data by top-level managers. Future research should address these by using more diverse samples and triangulating data sources. Additionally, further studies should explore the mechanisms through which Leadership 5.0 influences key Industry 5.0 outcomes, such as innovation and reliability, and verify its alignment with Industry 5.0 characteristics, assessing how this fit impacts desired outcomes.

3.7.2. 2nd stage of research – Leadership 5.0 and Organizational Reliability – static approach

The main aim of the second stage of study was to examine the influence of Leadership 5.0 on organizational reliability through sustainable innovation, creativity, collaboration, and intraorganizational trust, showing the static approach. The research has fulfilled this aim by providing a detailed theoretical framework and empirical verification of the mechanism of Leadership 5.0 influence on organizational reliability.

The empirical findings demonstrated that Leadership 5.0 significantly influences organizational reliability through mechanisms involving sustainable innovation, creativity, collaboration, and intraorganizational trust. It shows that Leadership 5.0 promotes sustainable innovation by fostering an environment that encourages creativity

and collaboration, essential for long-term organizational success in a dynamic and uncertain environment. Intraorganizational trust plays a crucial role in the positive impact of Leadership 5.0 on organizational reliability. Leaders who demonstrate openness, inclusivity, and support for employee autonomy contribute to a culture of trust, enhancing overall organizational performance. The developed model explaining how Leadership 5.0 influences organizational reliability also serves as a nomological validation of the Leadership 5.0 construct itself, which was first proposed by Bienkowska et al. (2024). The identified cause-effect relationships align with established theories in management science. What is more, the findings support the idea that Leadership 5.0 suits organizations operating within the Industry 5.0 framework. Results show that as organizations advance in implementing Industry 5.0, the impact of Leadership 5.0 on organizational reliability strengthens.

Despite the significant findings, the study has certain limitations. The research was conducted using one sample of organizations, which may limit the generalizability of the findings to different cultural or regional contexts. The reliance on self-reported data from top-level managers may introduce bias. However, the available statistical tests did not confirm its presence. Rigorous statistical tests were employed to ensure reliability and validity. However, future studies could benefit from triangulating data sources. The study's cross-sectional design does not capture the long-term effects of Leadership 5.0 on organizational reliability. Longitudinal studies are needed to observe the sustained impact of leadership practices over time.

Future research should address these limitations and further explore how Leadership 5.0 is adopted and its effects across different cultural and regional contexts. Such an extension will provide a more comprehensive understanding of its global applicability. Conducting longitudinal studies to examine the long-term impact of Leadership 5.0 on organizational reliability and other performance metrics will provide deeper insights into its effectiveness. As technology evolves, future research may also explore how emerging technologies influence the traits and behaviors associated with Leadership 5.0, ensuring its relevance and effectiveness in an ever-changing industrial landscape.

3.7.3. 3rd stage of research – Leadership 5.0 and Organizational Reliability – dynamic approach

The main aim of the third stage of the study was to examine the influence of Leadership 5.0 on organizational reliability through EDCs, IT adaptability, entrepreneurship, and sustainable innovation, showing the dynamic approach. The research has fulfilled

this aim by providing a detailed theoretical framework and empirical verification of the mechanism of Leadership 5.0 influence on organizational reliability.

The empirical findings demonstrated that Leadership 5.0 significantly influences organizational reliability through mechanisms involving EDCs, IT adaptability, entrepreneurship, and sustainable innovation. It shows that Leadership 5.0 promotes entrepreneurship and next sustainable innovation by fostering EDCs and IT adaptability, which is critical in a dynamic and uncertain environment. In this way, it is proven that the EDCs and IT adaptability play a crucial role in the positive impact of Leadership 5.0 on organizational reliability in organizations operating with the Industry 5.0 concept, as they refer to the two most important resources in the Industry 5.0 concept (Breque et al., 2021) and, at the same time, two components of organizational reliability (Bieńkowska and Tworek, 2020), i.e. the interaction of human and technology (here: IT) in the service of achieving the set goals of the organization as a whole. By emphasizing and supporting continuous learning of employees and IT systems development, 5.0 leaders promote the dynamic capabilities of employees and IT by influencing employees' entrepreneurial attitudes that foster sustainable innovation, which ultimately determines reliable human-robot collaboration in the organization.

Furthermore, the model developed to explain how Leadership 5.0 affects organizational reliability also serves as further nomological validation of the Leadership 5.0 construct. The causal relationships identified, given the dynamic approach, are in line with well-established theories in management science. In addition, the findings support the thesis that Leadership 5.0 is particularly suitable for organizations operating within Industry 5.0. The results show that as organizations progress in implementing Industry 5.0, the impact of Leadership 5.0 on organizational reliability is strengthened.

Although this part of study offers valuable insights, it has some limitations. The complex interdependencies among Leadership 5.0, IT adaptability, and intrapreneurship involve intricate feedback loops that may not be fully captured within the theoretical framework, potentially oversimplifying these relationships. The study was based on a single sample of organizations, which may restrict the generalizability of the findings across various cultural or regional contexts. Additionally, using self-reported data from top-level managers could introduce bias; however, statistical tests conducted did not indicate its presence. While rigorous statistical methods were applied to ensure reliability and validity, future research could enhance robustness by triangulating data sources.

The measurement of IT adaptability and intrapreneurial behavior also poses challenges due to their multifaceted nature and reliance on subjective perceptions, which

may vary significantly across industries and cultural settings. The focus on Industry 5.0, emphasizing advanced technologies and human-centric approaches, may restrict the findings' applicability to industries or organizations operating in less technologically advanced or resource-intensive contexts. Furthermore, the focus on cross-industry collaboration, central to the Industry 5.0 paradigm, may need more relevance for highly specialized or resource-constrained organizations. Addressing these limitations in future studies would enhance the robustness and applicability of the conclusions, particularly across diverse organizational and industry contexts.

Lastly, the rapidly evolving technological landscape could alter the relevance and impact of these factors over time, underscoring the need for ongoing research to capture the long-term effects of Leadership 5.0 on organizational reliability. Longitudinal studies are recommended to examine the sustained impact of leadership practices over time.

Future research should address these limitations and further explore how Leadership 5.0 impacts not so much on organizational reliability but on the other components of the Industry 5.0 concept. The effect on important human-centric values, such as employee well-being, is particularly interesting.

Conclusions

The monograph introduced, operationalized, and empirically verified the Leadership 5.0 concept, explaining how it affects organizational reliability under specific conditions, and identified two mechanisms of influence: static and dynamic. The research progressed in three cumulative stages, starting with construct validation, then a static mechanism verification, and then a dynamic mechanism verification. It was based on a critical literature analysis, which made it possible to establish the construct's scope and the mechanisms of its influence on organizational reliability, as well as on empirical research conducted with a large and diverse sample of Polish organizations and a rigorous analysis of measurement scales.

The first stage of the research aimed to conceptualize and empirically verify Leadership 5.0 as a multidimensional construct aligned with the principles of Industry 5.0, such as human-centricity, sustainability, resilience, and technological adaptability. The results confirmed that Leadership 5.0 can be understood as a three-dimensional construct, encompassing leader traits, behaviors toward employees, and behaviors toward the organization. Leader's traits included as vision, open-mindedness, empathy, emotional intelligence, lifelong learning, and a global mindset emerged as essential. Behaviors toward employees included fostering autonomy, teamwork, creativity, inclusivity, continuous development, and responsible leadership. Finally, behaviors toward the organization were reflected in open communication, fair systems, commitment to sustainability, technological adaptability, and cross-industry collaboration. The construct proved to be coherent, valid, and reliable, which establishes a strong foundation for its use in future research. This stage contributes to management science by positioning Leadership 5.0 as a situationally consistent style for Industry 5.0, by providing a validated measurement tool, and by integrating elements of transformational, inclusive, servant, and authentic leadership with sustainability and socio-technical collaboration, which remain at heart of Industry 5.0 concept.

The second stage of the research examined the influence of Leadership 5.0 on organizational reliability through static mechanisms including creativity, collaboration, sustainable innovation, and intraorganizational trust. The results showed that Leadership 5.0 significantly enhances organizational reliability through these pathways, with trust and creativity playing particularly important roles. Sustainable innovation emerged as a central mediator, linking leadership practices to reliability outcomes. The findings also indicated that the effects of Leadership 5.0 become stronger in organizations that are more advanced in implementing the principles of Industry 5.0. This stage contributes to management science by clarifying the static mechanisms through which Leadership 5.0 operates, showing that human-centric and socio-technical practices are crucial for organizational reliability. It also demonstrates that the maturity of Industry 5.0 implementation amplifies the effects of Leadership 5.0, and it validates the construct by embedding it in a tested reliability model.

The third stage of the research focused on dynamic mechanisms, examining how Leadership 5.0 affects organizational reliability through EDCs, IT adaptability, intrapreneurship, and sustainable innovation. The findings revealed that Leadership 5.0 fosters EDCs and IT adaptability, which in turn drive intrapreneurial behavior. Intrapreneurship leads to sustainable innovation, which then strengthens organizational reliability. This confirms the existence of a full mediated chain linking Leadership 5.0 to organizational reliability through dynamic capabilities and innovation. The results also showed that these effects are stronger in organizations that have reached higher levels of Industry 5.0 implementation. This stage contributes to management science by identifying the dynamic mechanisms through which Leadership 5.0 enhances organizational reliability, linking human and technological adaptability to intrapreneurship and innovation. It positions Leadership 5.0 as a leadership style that builds dynamic capability portfolios within organization and stabilizes organizational reliability in dynamic environments.

Taken together, the three stages provide a complete picture of Leadership 5.0: a verified construct, a static mechanism, and a dynamic mechanism through which it strengthens organizational reliability (which together constitute a nomological verification of the construct). The research advances the fields of leadership, organizational reliability, and dynamic capabilities by defining Leadership 5.0 as the leadership style best suited for Industry 5.0, by demonstrating both static and dynamic enablers of organizational reliability, and by empirically integrating human-centric values with technological and sustainability imperatives. The overview of the results is presented in Figure 5.1.

	Main research results:	Contribution to management science :
1st STAGE ↓	confirmation that Leadership 5.0 can be understood as a three-dimensional construct, encompassing leader traits, behaviors toward employees, and behaviors toward the organization	positioning Leadership 5.0 as a situationally consistent style for I5.0, by providing a validated measurement tool, and by integrating elements of transformational, inclusive, servant, and authentic leadership with sustainability and socio-technical collaboration, which remain at heart of I5.0 concept
2nd STAGE ↓	confirmation that Leadership 5.0 enhances organizational reliability through trust and creativity playing particularly important roles; sustainable innovation emerged as a central mediator, linking leadership practices to reliability outcomes.	clarifying the static mechanisms through which Leadership 5.0 operates, showing that human-centric and socio-technical practices are crucial for organizational reliability; demonstrating that the maturity of I5.0 implementation amplifies the effects of Leadership 5.0
3rd STAGE ↓	confirmation that Leadership 5.0 fosters EDCs and IT adaptability, which in turn drive intrapreneurial behavior; intrapreneurship leads to sustainable innovation, which then strengthens organizational reliability	identifying the dynamic mechanisms through which Leadership 5.0 enhances organizational reliability, linking human and technological adaptability to intrapreneurship and innovation; demonstrating that the maturity of I5.0 implementation amplifies the effects of Leadership 5.0
The research advances the fields of leadership, organizational reliability, and dynamic capabilities by defining Leadership 5.0 as the leadership style best suited for I5.0, by demonstrating both static and dynamic enablers of organizational reliability, and by empirically integrating human-centric values with technological and sustainability imperatives.		

Figure 5.1. Overall research results. Source: own work

From a managerial perspective, the results suggest that organizations should invest in the development of Leadership 5.0 competencies, such as vision, emotional intelligence, continuous learning, openness, and data literacy, and in behaviors such as autonomy, inclusivity, fairness, and collaboration across industries. They should deliberately build EDCs and IT adaptability and empower intrapreneurship as a means of transforming these capabilities into sustainable innovation, which directly drives organizational reliability.

The study has limitations, including its single-country context and cross-sectional design, which constrain generalizability and long-term inference. Future research should adopt multi-country and longitudinal designs, refine measures of IT adaptability and intrapreneurship across industries, and examine the effects of Leadership 5.0 on broader outcomes of Industry 5.0, such as employee well-being, ethical technology integration, and human–robot collaboration. There is also a need to explore feedback loops between static and dynamic mechanisms to deepen understanding of how Leadership 5.0 operates over time.

Overall, the evidence demonstrates that Leadership 5.0 is conceptually robust, empirically validated, and practically relevant. It systematically enhances organizational reliability through both static and dynamic mechanisms, and its impact increases with the level of Industry 5.0 implementation. Consequently, Leadership 5.0 emerges as a central leadership paradigm for organizations operating at the intersection of human values, technology, and sustainability.

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Appendix

Leadership 5.0 – variables description

Leaders 5.0's Traits	
Visionary	Leader in our organization has the ability to envision the future of Industry 5.0 and its potential impact.
	Leader in our organization is able to effectively articulate the vision and goals of Industry 5.0.
	Leader in our organization communicates a clear and coherent vision of its functioning.
	Leader in our organization is a visionary.
	Leader in our organization is independent.
Open-Mindedness	Leader in our organization is open-minded.
Empathy and emotional intelligence	Leader in our organization is empathetic.
Lifelong Learning	Leader in our organization is eager to learn.
Global Mindset	Leader in our organization has a global mindset.
Feedback-Seeking and Openness to Criticism	Leader in our organization has a stable self-esteem.
	Leader in our organization takes criticism well and appreciates feedback.
	Leader in our organization has a willingness to take risks.
Data-driven decisions	Leader in our organization promotes data-driven decisions.
	Leader in our organization has the ability to analyze and interpret data to make informed decisions.
Leaders 5.0's – behaviors towards employees	
Supporting and Enhancing Employee Creativity	Leader in our organization supports employees' creativity.
Promoting Diversity and Inclusivity	Leader in our organization fosters inclusivity.
	Leader in our organization promotes diversity and inclusivity in the workforce and decision-making processes.
	Leader in our organization uses diversity management to support employees.

Supporting Continues Learning and Development	Leader in our organization demonstrates a commitment to ongoing learning and staying updated with industry trends.
	Leader in our organization promotes continuous learning.
	Leader in our organization supports learning and development among employees.
	Leader in our organization gives positive feedback.
	Leader in our organization supports the dynamic capabilities of employees.
Fostering Teamwork Cohesion	Leader in our organization supports teamwork.
	Leader in our organization is able to manage a digital team.
Empowering Employees through Autonomy	Leader in our organization encourages employees to contribute innovative ideas or suggestions for improvement.
	Leader in our organization is open to new ideas and suggestions for improvement from employees.
	Leader in our organization shows appreciation for employees' innovative ideas.
	Leader in our organization offers employees a great deal of autonomy.
Demonstrating Responsible Leadership	Leader in our organization has strong internal motivation.
	Leader in our company supports employees in considering social interests, environmental protection, as well as relations with various groups: customers, employees, and the local community.
Leaders 5.0's – behaviors towards the organization	
Open Communication	Leader in our organization promotes open communication.
	Leader in our organization is able to listen and communicate while simultaneously trying to solve problems and lead.
Fostering Fair Systems	Leader in our organization promotes supportive work environment.
	Leader in our organization promotes a motivational system aiming at supporting creativity and internal motivation.
Committing to Sustainability	Leader in our organization incorporates sustainable practices and considers environmental and social impacts in Industry 5.0 initiatives.
Technological Adaptability	Leader in our organization demonstrates a willingness to embrace and navigate through rapid technological advancements.
Facilitating Collaboration Across Industries	Leader in our organization possesses skills in fostering collaboration and partnerships across industries and sectors.

Leadership 5.0

New leadership style for Industry 5.0

The monograph presents the concept of Leadership 5.0 – a new leadership style developed as a response to the challenges of the Industry 5.0 era, in which organizations must integrate rapid technological advancement with human-centric values, sustainability, and resilience. Leadership 5.0 is defined as a style that combines leaders' personal traits, their behaviors toward employees, and their actions toward the organization, in order to harmonize technological innovation with the well-being of people and the broader social environment.

The monograph fills an important research gap: despite growing interest in Industry 5.0, existing work has largely focused on technology and processes, overlooking the role of leadership in shaping organizational outcomes. The authors ground the Leadership 5.0 concept in situational and contingency theories, assuming that leadership style should stem from the overarching purpose of the organization – the implementation of Industry 5.0 principles.

The aim of the monograph is to identify, define, and empirically validate the construct of Leadership 5.0, determine the mechanisms through which it influences organizational reliability, and examine the role of both static and dynamic factors within this mechanism.

In Industry 5.0, success is not only about achieving results but also minimizing errors and ensuring stable organizational functioning under conditions of constant change. For this reason, the analysis focuses on how Leadership 5.0 affects organizational reliability in both static terms (through culture, collaboration, creativity, and trust) and dynamic terms (by strengthening employees' dynamic capabilities, technological adaptability, entrepreneurial orientations, and sustainable innovation).

The monograph presents empirical findings that enabled the validation of the Leadership 5.0 construct and confirmed its significant impact on organizational reliability. Ultimately, Leadership 5.0 emerges as a multidimensional leadership style essential for building resilient, human-centered, and technologically mature organizations in the Industry 5.0 era.

Keywords: Leadership 5.0, Industry 5.0, leadership style, organizational reliability

The monograph refers to Leadership 5.0, which is a concept precisely aimed at supporting the new Industry 5.0 idea currently being implemented in practice, where organizations must not only adapt to rapid technological advancements but also contend with the evolving dynamics of human-centric values, sustainability, and organizational resilience. Leadership 5.0 (leadership suited for Industry 5.0) thus blends individual traits of leaders, their behavior towards employees, and towards the organization, harmonizing technological advancement with the well-being of employees and society. The monograph provides a complete nomological verification for the Leadership 5.0 concept, offering a verified construct as well as the static and dynamic mechanisms through which Leadership 5.0 influences organizational reliability.

The monograph is the outcome of research conducted by the Management Concept Research Team led by Prof. Agnieszka Bieńkowska at the Department of Management Systems and Organizational Development of the Faculty of Management at the Wrocław University of Science and Technology. The team's scientific interests focus on issues related to the broadly understood theory of organization and management, including contemporary management methods and techniques, with an emphasis on the use of IT tools in management based on a human-centered vision of the organization as an integrated whole.



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