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Transforming Leadership in the Context of Human-AI Complementarity

Abstract. Introduction. The increasing integration of artificial intelligence into organizational processes is reshaping traditional understandings of leadership. While existing studies have extensively explored digital leadership and human-AI collaboration, limited attention has been devoted to explaining how leadership operates across multiple levels in the context of human-AI complementarity.

Purpose. The purpose of the article is to advance the understanding of leadership transformation in the context of human-AI complementarity by developing a multi-level conceptual framework that explains how leadership is enacted across individual, team, and organizational levels in AI-enabled environments.

Results. The article conceptualizes human-AI complementarity as a dynamic process through which the distinct capabilities of humans and artificial intelligence are aligned to generate superior organizational outcomes. Building on this perspective, a multi-level framework of leadership is proposed, encompassing cognitive complementarity at the individual level, hybrid collaboration at the team level, and system design and governance at the organizational level. The framework suggests that leadership effectiveness depends on the alignment of these interconnected levels and on the ability of leaders to coordinate cognitive, collaborative, and organizational processes within complex socio-technical systems. The findings further suggest that leadership transformation is characterized by a shift from viewing leaders primarily as sources of expertise and direction toward recognizing their role in creating conditions for the effective alignment and utilization of complementary human and AI capabilities.

Conclusions. Leadership in the context of human-AI complementarity should be understood as a dynamic capability that facilitates the integration of human and artificial intelligence across multiple levels of analysis. The proposed framework contributes to the emerging discourse on leadership transformation by providing a structured perspective on the mechanisms through which human-AI complementarity can be translated into sustainable organizational value and offers a foundation for future theoretical and empirical research in AI-enabled environments.

Keywords: leadership; digital leadership; artificial intelligence; hybrid intelligence; human-AI complementarity; leadership competencies.

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Трансформація лідерства у контексті комплементарності людини та штучного інтелекту

Анотація. Стрімке поширення технологій штучного інтелекту в діяльності організацій змінює характер управлінських і лідерських процесів та зумовлює необхідність переосмислення ролі лідерства в сучасному цифровому середовищі. Метою статті є поглиблення розуміння трансформації лідерства в умовах комплементарності людини та штучного інтелекту шляхом розроблення багаторівневої концептуальної моделі, яка пояснює особливості реалізації лідерства на індивідуальному, командному та організаційному рівнях. Запропонована модель охоплює когнітивну комплементарність на індивідуальному рівні, гібридну взаємодію на рівні команди, а також проектування та управління організаційними системами на організаційному рівні. Обґрунтовано, що ефективність лідерства в умовах використання рішень на основі штучного інтелекту залежить від узгодженості цих взаємопов'язаних рівнів, а також від здатності лідерів координувати когнітивні, командні та організаційні процеси. Встановлено, що трансформація лідерства проявляється у зміщенні акценту від сприйняття лідера як основного джерела експертизи і визначення напрямів розвитку до його ролі у створенні умов для ефективного поєднання та використання взаємодоповнювальних можливостей людини й штучного інтелекту. Запропонована модель розширює сучасні уявлення про цифрове лідерство, формує цілісне бачення механізмів реалізації комплементарності людини та штучного інтелекту та створює теоретичне підґрунтя для подальших досліджень лідерських компетентностей в умовах поширення технологій штучного інтелекту.

Ключові слова: лідерство; цифрове лідерство; штучний інтелект; гібридний інтелект; комплементарність людини та штучного інтелекту; лідерські компетентності.

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Formulation of the problem. The rapid advancement of artificial intelligence (AI) technologies is fundamentally reshaping organizational structures, work processes, and managerial practices, thereby redefining the nature and scope of leadership in contemporary organizations. As AI systems evolve from passive tools into increasingly autonomous and adaptive agents, organizations are transitioning toward AI-enabled environments characterized by distributed decision-making, continuous data-driven processes, and complex human-machine interactions. In this context, leadership can no longer be understood solely as a function of interpersonal influence, rather, it emerges as an integrative capability that enables the alignment of human and artificial intelligence in pursuit of organizational objectives.

Recent scholarly contributions emphasize that the effectiveness of AI adoption does not depend exclusively on technological sophistication but is critically contingent upon leadership practices that shape how humans and intelligent systems interact. In particular, the concept of human-AI complementarity has gained prominence as a central theoretical lens, suggesting that superior outcomes are achieved when the distinct strengths of humans – such as contextual reasoning, ethical judgment, and creativity – are effectively combined with the analytical, predictive, and scalable capabilities of AI systems [1; 2]. From this perspective, leadership plays a critical role in designing, facilitating, and sustaining such complementarity across multiple organizational levels, ensuring that technological integration enhances rather than displaces human value creation.

At the same time, the emergence of so-called human-agentic workforces – hybrid configurations in which human employees collaborate with autonomous or semi-autonomous AI agents – introduces new challenges for leadership theory and practice. Analytical reports indicate that organizations are increasingly integrating AI agents as active participants in workflows, thereby expanding traditional workforce models and redefining task allocation, coordination, and accountability structures [3; 4]. These developments require leaders to move beyond traditional supervisory roles toward the design and governance of socio-technical systems in which human and artificial actors interact dynamically. Consequently, leadership must address issues such as trust calibration, transparency, and ethical oversight, while simultaneously fostering adaptability and continuous learning within the workforce.

Despite the growing recognition of these dynamics, the existing literature remains fragmented. While prior research has extensively examined digital leadership, human-AI collaboration, and AI-driven workforce transformation [4-8], there is a lack of integrative frameworks that connect these domains and explain how leadership operates across multiple levels in AI-enabled environments. In response to this gap, the present study aims to develop a comprehensive conceptualization of leadership in the age of artificial intelligence by

integrating the perspectives of human-AI complementarity and multi-level leadership.

Analysis of recent research and publications. Existing research on leadership in AI-enabled environments spans several interrelated domains, including digital leadership, human-AI collaboration, hybrid intelligence, and AI-driven workforce transformation. Early contributions to digital transformation literature emphasized the strategic role of leadership in aligning technological adoption with organizational change, highlighting that successful digital transformation depends less on technology itself and more on leadership capabilities, vision, and organizational culture [7; 9]. These studies established the foundation for understanding leadership as a critical enabler of digital adaptation, yet they primarily focused on technology-driven change rather than the deeper integration of human and artificial intelligence. In particular, G. Westerman et al. (2014) argue that successful digital transformation depends on leadership's ability to align technological initiatives with organizational strategy, culture, and change rather than on technology adoption alone [7]. Subsequent research shifted attention toward the interaction between humans and AI systems, conceptualizing this relationship through the lens of human-AI collaboration and hybrid intelligence. A central contribution of this stream lies in the recognition that AI does not simply replace human labor but rather augments it, creating new forms of socio-technical systems in which humans and intelligent machines jointly perform tasks [1; 8]. In this context, the concept of hybrid intelligence has been introduced to describe the combination of human cognitive and socio-emotional capabilities with machine-based analytical power, enabling performance outcomes that exceed those achievable by either humans or AI alone [1; 10]. D. Dellermann et al. (2019) were among the first to conceptualize hybrid intelligence as a systematic combination of human and artificial intelligence designed to leverage the unique strengths of each and achieve outcomes unattainable by either acting independently [1].

Building on this perspective, a growing stream of research has explored the principle of human-AI complementarity as a mechanism underlying effective collaboration. Complementarity is understood as the alignment of distinct yet interdependent capabilities of humans and AI systems, which together generate superior outcomes compared to isolated performance. Recent studies highlight that complementarity emerges from differences in information processing, expertise, and decision-making styles, and depends on the effective integration of these capabilities within organizational processes [11-12]. Building on this perspective, P. Hemmer et al. (2021), through a structured literature review, identified a range of human, technological, and interaction-related factors that influence complementary team performance in human-AI systems [11]. However, despite its theoretical relevance, empirical evidence

suggests that achieving true complementarity remains challenging, as human-AI systems often underperform due to issues related to trust, usability, and misalignment between human and algorithmic decision processes [12]. This indicates that complementarity is not an automatic outcome of technological adoption but requires deliberate design and leadership involvement, whereby leaders actively align human and algorithmic capabilities and cultivate organizational conditions that enable effective interaction between human and AI agents.

In parallel, recent research has increasingly focused on the implications of AI for managerial decision-making and leadership practices. Studies in this domain emphasize that leaders differ significantly in their approaches to collaborating with AI, shaped by their perceptions of algorithmic reliability, autonomy, and control [13]. Within this context, the evolution from Leadership 4.0, which emphasizes digital integration and data-driven decision-making, toward Leadership 5.0, characterized by a human-centric, adaptive, and ethically grounded approach, provides an important conceptual lens for understanding these shifts [14; 15]. B. Oberer and A. Erkollar (2018) emphasize that leadership in the Industry 4.0 depends on the ability to integrate technological and human dimensions of organizational development, highlighting the need to balance innovation, digitalization, and employee engagement [16], whereas J. Whitehead et al. (2025) view Leadership 5.0 as an attempt to reconcile technological advancement with human-centric values, sustainability, and organizational resilience [15]. Moreover, the literature highlights the emergence of new leadership challenges associated with algorithmic management, including issues of accountability, transparency, and the calibration of trust in AI systems [6; 17]. These findings suggest that leadership in AI-enabled environments requires not only technical understanding but also the ability to manage complex socio-technical interactions.

Another important stream of research examines the transformation of work and workforce structures under the influence of AI. Scholars and practitioners increasingly refer to the emergence of hybrid or human-agent workforces, in which AI systems act as semi-autonomous agents participating in organizational processes. Empirical studies demonstrate that the effective management of such workforces requires new forms of coordination, task decomposition, and capability alignment, as well as the development of human AI-related skills that support innovation and organizational performance [18]. This shift is accompanied by a redefinition of leadership roles, moving from direct supervision toward the design and governance of systems in which human and artificial actors interact dynamically.

Despite these advances, the literature remains conceptually fragmented. While significant progress has been made in understanding digital leadership, human-AI collaboration, and AI-driven workforce transformation,

these streams are often examined in isolation, with limited integration across levels of analysis. In particular, there is a lack of comprehensive frameworks that explain how leadership operates simultaneously at the individual, team, and organizational levels in AI-enabled environments. Addressing these gaps requires a more integrative approach that connects existing insights and advances a coherent conceptualization of leadership in the age of artificial intelligence.

Formulation of research goals. The purpose of the article is to advance the understanding of leadership transformation in the context of human-AI complementarity by developing a multi-level framework that explains how leadership is enacted across individual, team, and organizational levels in AI-enabled environments. The article seeks to integrate insights from digital leadership, human-AI collaboration, hybrid intelligence, and Leadership 5.0 research into a coherent perspective that captures the evolving role of leadership in complex socio-technical systems. Particular attention is devoted to explaining how complementarity between human and artificial intelligence can be operationalized through leadership practices that align cognitive processes, collaborative interactions, and organizational structures. The article provides a theoretical foundation for understanding leadership in the context of human-AI complementarity and offers a conceptual basis for future research on the capabilities and mechanisms that enable effective human-AI collaboration.

Presentation of the main research material. The integration of artificial intelligence into organizational processes is not merely extending existing leadership practices but is reshaping their underlying logic. In AI-enabled environments, where decision-making is increasingly supported or partially executed by intelligent systems, leadership is no longer confined to directing human actors but extends to shaping the interaction between human and artificial agents. This transition reflects a movement toward system-level leadership, where the primary task of leaders is to ensure coherence between technological capabilities, organizational goals, and human contributions. A central outcome of this transformation is the redefinition of how authority and expertise are constituted within organizations. As algorithmic systems assume a more active role in generating insights and recommendations, the locus of expertise becomes distributed across human and artificial actors. Leaders, therefore, are increasingly positioned not as primary decision-makers, but as integrators of knowledge sources who validate, contextualize, and translate AI-generated outputs into strategically meaningful actions.

At the same time, the temporal dynamics of leadership are changing. AI-enabled environments are characterized by real-time data flows and continuous feedback loops, which compress decision cycles and reduce the distinction between decision-making and execution. Consequently, leadership effectiveness

increasingly depends on the ability to manage dynamic alignment rather than static optimization. While AI enhances efficiency and predictive capacity, it also risks displacing human judgment or narrowing the scope of human involvement in decision processes. Leaders must therefore actively preserve meaningful human participation, ensuring that employees remain engaged as contributors rather than passive overseers of automated systems. In addition, the increasing opacity of advanced AI systems introduces challenges related to accountability and explainability. When decisions are co-produced by humans and algorithms, responsibility becomes distributed and potentially ambiguous. Leaders are thus required to establish governance mechanisms that clarify accountability, ensure transparency, and maintain ethical standards in decision-making processes. This expands the scope of leadership beyond performance management toward the stewardship of responsible AI use, including considerations of fairness, bias, and long-term societal impact.

Within this evolving context, Leadership 4.0 provides an important conceptual foundation by emphasizing the alignment of leadership with the demands of digital transformation. It foregrounds agility, data-driven decision-making, and the capacity to operate within technologically mediated environments. Leaders are expected to foster innovation, enable collaboration across digital platforms, and create organizational conditions that support continuous learning and adaptability [14; 16]. Importantly, Leadership 4.0 reframes leadership as a facilitating rather than directive function, where the leader's role is to enable networks of interaction and ensure that digital capabilities are effectively embedded into organizational processes.

However, the primary focus of Leadership 4.0 on digital capabilities and performance alignment does not fully capture the ethical, relational, and human-centric challenges introduced by AI. This gap has led to the emergence of Leadership 5.0, which reflects a broader shift toward integrating technological advancement with human values, sustainability, and resilience. Leadership 5.0 emphasizes that effective leadership in AI-enabled environments requires not only technological competence but also emotional intelligence, ethical reasoning, and a commitment to human well-being [15; 19]. It positions leaders as mediators between efficiency and responsibility, tasked with ensuring that AI enhances rather than diminishes human potential. A distinctive feature of Leadership 5.0 is its focus on human-machine collaboration as a core organizational capability. Rather

than treating technology as an external tool, this perspective conceptualizes AI as an active participant in value creation processes. Accordingly, leaders must design interaction frameworks in which human creativity, judgment, and ethical reasoning are effectively combined with machine intelligence. This involves fostering a culture of experimentation, supporting continuous skill development, and creating psychologically safe environments in which employees can engage productively with AI systems. At the same time, Leadership 5.0 extends the scope of leadership responsibility to include societal and environmental considerations, reflecting the growing importance of sustainability and long-term impact in organizational decision-making [19].

Beyond these models, contemporary research points toward the emergence of integrative and adaptive leadership approaches that are particularly suited to AI-enabled environments [20]. One of the most influential perspectives in this regard is adaptive leadership, which conceptualizes leadership as the capacity to mobilize individuals and organizations to respond to complex, non-routine challenges. Closely related to this is the concept of distributed leadership, which reflects the decentralization of authority in digitally mediated and AI-supported organizations. As decision-making becomes increasingly dispersed across teams, platforms, and algorithmic systems, leadership is no longer concentrated in a single individual but distributed across multiple actors. In this context, leaders act as facilitators of collective intelligence, enabling effective collaboration not only among team members but also between human and artificial agents. This approach is particularly relevant for hybrid teams, where coordination depends on the integration of diverse competencies and the alignment of human and machine contributions. Such approaches converge on the idea that leadership is becoming less about individual authority and more about enabling collective intelligence across human-AI configurations. Leaders are required to simultaneously facilitate collaboration, manage technological systems, and uphold ethical standards, suggesting that no single leadership model is sufficient in isolation. Instead, effective leadership in AI-enabled environments emerges from the ability to synthesize multiple approaches, adapting them to the specific context and challenges faced by the organization. To structure the transformation of leadership in AI-enabled environments, it is useful to group contemporary leadership models into three domains (Table 1).

Table 1 Leadership domains in AI-enabled environments: analytical and competency perspective

Domain	Leadership models	Analytical focus	Leadership roles and tasks	Core leadership competencies
Digital and Technology-Oriented	Digital Leadership (including Leadership 4.0), Data-Driven Leadership, Algorithmic Leadership	Focuses on the integration of AI and data into decision-making and organizational processes, emphasizing the strategic use of algorithmic systems and digital infrastructures.	Leaders interpret AI-generated insights, integrate AI into workflows, and define the scope of automation in decision-making processes. They ensure alignment between technological capabilities and strategic objectives.	Data literacy, AI literacy, analytical thinking, and the ability to critically evaluate and interpret algorithmic outputs. Emphasis is placed on translating data into actionable insights and maintaining informed judgment in data-driven environments.
Human and Ethical-Oriented	Transformational Leadership, Servant Leadership, Responsible Leadership, Leadership 5.0 (emerging paradigm)	Emphasizes human-centric leadership, ethical responsibility, trust, and the preservation of meaningful work in technology-mediated environments.	Leaders foster trust in AI systems, support employee adaptation to technological change, and ensure that AI is used responsibly and in alignment with organizational values.	Emotional intelligence, ethical reasoning, communication, trust-building, and the ability to maintain engagement and human agency in automated environments.
Complexity and Systems-Oriented	Adaptive Leadership, Distributed Leadership, Systems Leadership, Complexity Leadership, Ambidexterity-based Leadership	Focuses on managing complexity, interdependence, and dynamic interactions within socio-technical systems involving both human and AI actors.	Leaders coordinate hybrid teams, manage distributed roles across human and AI agents, and enable continuous adaptation of processes and structures.	Systems thinking, adaptability, coordination skills, and the ability to manage interdependencies and dynamic interactions across multiple organizational levels.

Source: developed by the author based on [1; 5; 14-20]

These reflect the key shifts identified in the analysis: the growing role of digital technologies and data in decision-making, the increasing importance of human-centric and ethical considerations, and the rising complexity of coordinating human-AI systems. Accordingly, digital and technology-oriented models capture the technological dimension of leadership, human and ethical-oriented models emphasize the preservation of human value and responsibility, and complexity and systems-oriented models address the challenges of managing dynamic and interconnected organizational environments. Together, these domains provide a coherent framework for understanding how leadership is evolving in the context of AI.

The reviewed leadership models differ in their level of theoretical maturity, ranging from well-established theories (e.g., transformational and complexity leadership) to emerging perspectives and practice-oriented approaches (e.g., Leadership 5.0 and data-driven leadership). This diversity reflects the rapid development of AI-enabled environments, where practice often evolves faster than theory. As a result, each model captures only a specific aspect of leadership, such as the use of technology, the human dimension, or the management of complexity. From a practical perspective, this means that no single model is sufficient on its own. Effective leadership in AI-enabled environments requires a diverse set of competencies,

each associated with different domains of leadership practice. However, these competencies remain fragmented and domain-specific, highlighting the need for integrative capabilities that enable leaders to connect technological, human, and systemic dimensions. In this regard, the synthesis of these approaches highlights the growing importance of cross-domain competencies that enable leaders to navigate, connect, and operationalize diverse dimensions of leadership in technology-mediated organizational systems.

Complementarity in Human-AI Collaboration from a Leadership Perspective

The analysis of contemporary leadership approaches in AI-enabled environments demonstrates that leadership is increasingly distributed across technological, human, and systemic dimensions, each requiring distinct yet interrelated competencies. While these perspectives provide important insights, they do not fully explain how leadership can ensure effective interaction between human and artificial intelligence in practice. In this context, the concept of complementarity in human-AI collaboration offers a more integrated understanding of leadership by focusing on how different forms of intelligence can be aligned to enhance organizational outcomes. Rather than viewing artificial intelligence as a substitute for human capabilities, recent research conceptualizes AI as a complementary resource that enhances, extends, and reshapes human decision-

making and organizational performance [6]. From a leadership perspective, complementarity is not an inherent outcome of technological adoption but a condition that must be actively constructed and maintained. It emerges when the distinct strengths of human cognition, such as contextual understanding, ethical reasoning, and creativity, are combined with the analytical power, scalability, and consistency of AI systems. This implies that leadership is concerned with defining the boundaries and interaction mechanisms between human and artificial agents, ensuring that their contributions are not redundant but mutually reinforcing [1]. In this sense, complementarity reflects a shift from task allocation to capability alignment, where the focus is placed on how different forms of intelligence interact to produce superior outcomes. Importantly, the effectiveness of human-AI complementarity depends on how leaders interpret and operationalize the roles of both humans and AI within organizational processes. Empirical studies suggest that organizations achieve higher performance when AI is used to augment rather than replace human decision-making, particularly in complex and uncertain environments where purely algorithmic solutions may be insufficient [8]. This requires leaders to design hybrid decision structures in which responsibility is shared and dynamically adjusted. Such an approach challenges traditional assumptions about authority and expertise, as decision quality becomes contingent on the integration of diverse sources of knowledge rather than on individual judgment alone. The concept of complementarity also highlights the importance of relational and interpretive processes in leadership. Effective human-AI collaboration depends not only on technological capabilities but also on the extent to which individuals trust, understand, and meaningfully engage with AI systems. Leaders play a critical role in shaping these conditions by fostering transparency in algorithmic processes, supporting the development of AI-related competencies, and creating environments in which employees can critically engage with machine-generated insights.

At the same time, complementarity introduces new challenges that redefine the scope of leadership responsibility. One such challenge concerns the calibration of interaction between human and artificial agents, particularly in situations where their outputs diverge. Leaders must develop the capacity to manage such tensions, determining when to rely on algorithmic recommendations and when to prioritize human judgment. This requires a nuanced understanding of the strengths and limitations of both forms of intelligence, as well as the ability to operate under conditions of

uncertainty and partial information. Furthermore, the increasing interdependence between human and AI actors raises questions of accountability, as decision outcomes are often co-produced, making it more difficult to attribute responsibility to a single source.

Building on these insights, complementarity can be understood as a dynamic and context-dependent process that unfolds across multiple levels of the organization. At the individual level, it involves the interaction between human cognition and AI-supported analysis, at the team level, it shapes collaboration within hybrid groups, and at the organizational level, it influences how systems, processes, and decision architectures are designed. This multi-level nature of complementarity reinforces the need for leadership approaches that are capable of integrating technological, human, and systemic perspectives in a coherent manner. This perspective sets the foundation for further analysis of the mechanisms through which such integration can be achieved, particularly through the development of advanced competencies that support effective interaction between human and artificial intelligence in organizational settings.

A Multi-Level Framework of Leadership in Human-AI Complementarity

According to the understanding of complementarity as a dynamic alignment between human and artificial intelligence, leadership in AI-enabled environments can be more precisely conceptualized as a multi-level capability. Rather than operating as a single, unified activity, leadership unfolds across interconnected layers of organizational reality, where the interaction between human and AI systems takes different forms. This perspective allows for a more structured interpretation of how complementarity is enacted in practice, highlighting that effective leadership depends on the ability to align cognitive processes, collaborative interactions, and organizational design in a coherent manner [1].

Figure 1 presents a structural representation of leadership in human-AI complementarity across multiple levels of analysis. The model conceptualizes leadership as an integrative capability that connects individual-level cognitive processes, team-level hybrid collaboration, and organizational-level system design and governance. The inclusion of a cross-level dimension emphasizes the alignment and coordination of these processes, ensuring coherence between cognition, interaction, and system structures. Together, the figure highlights how leadership emerges through the integration of capabilities distributed across levels rather than being confined to a single locus of action.

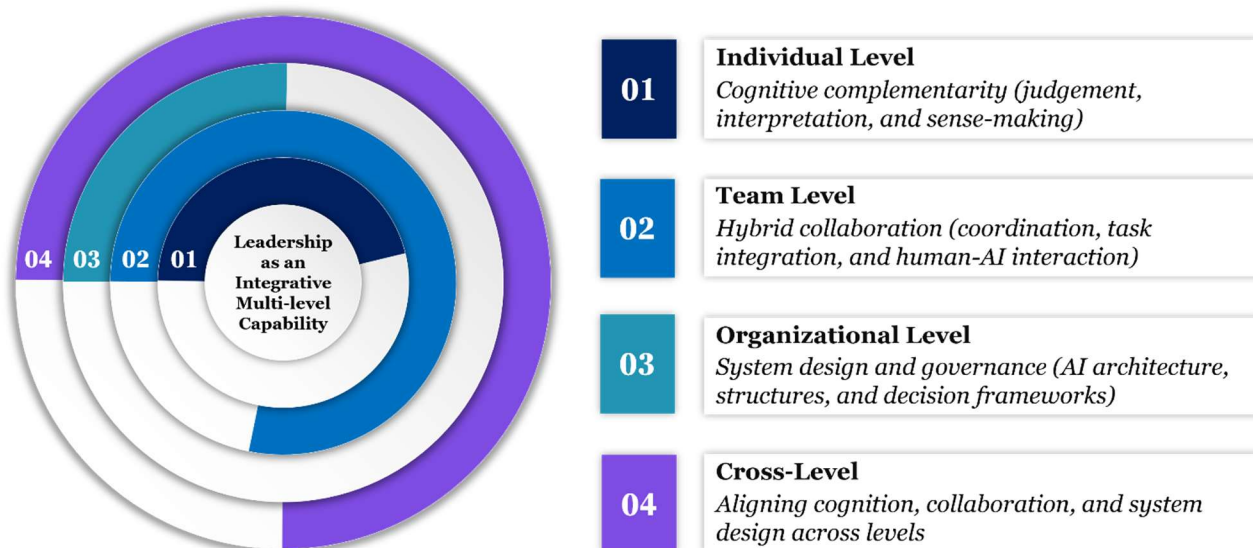


Figure 1 – Structural representation of multi-level leadership in human-AI complementarity

Source: developed by the author based on [1; 2; 6; 8; 17]

The multi-level perspective reflects the increasing complexity of AI-enabled environments, where decision-making, coordination, and value creation are distributed across individuals, teams, and organizational systems. At each level, leadership performs a distinct function, yet these functions are interdependent. The effectiveness of human-AI collaboration therefore depends not only on how well each level is managed, but also on how consistently they are aligned. In this sense, leadership is not confined to a specific position or role but operates as an integrative mechanism that connects different layers of human-AI interaction [6].

Individual-Level Leadership and Cognitive Complementarity

At the individual level, complementarity is primarily expressed through the interaction between human cognition and AI-supported analysis. Leadership at this level focuses on shaping how individuals engage with AI in their decision-making processes. Rather than replacing human judgment, AI serves as a cognitive extension that enhances analytical capacity and expands the range of available information. However, the value of this interaction depends on the ability of individuals to critically interpret and contextualize AI-generated outputs [8]. Leaders play a key role in developing this form of cognitive complementarity by fostering the skills and mindset required for effective human-AI interaction. This involves encouraging reflective use of AI, where individuals do not passively accept algorithmic recommendations but actively evaluate their relevance and limitations. At the same time, leaders must create conditions that support confidence and trust in AI systems, ensuring that individuals are willing to engage with them as partners in decision-making. In this context, leadership is closely linked to the development of informed judgment, where human reasoning and

machine-based analysis are combined to improve decision quality.

Team-Level Leadership and Hybrid Collaboration

At the team level, complementarity emerges through the coordination of hybrid collaboration, where human actors and AI systems jointly contribute to task execution and problem-solving. Leadership in this context is concerned with structuring interactions within teams that include both human members and AI-based tools or agents. This requires a shift from traditional team management toward the facilitation of distributed collaboration, where roles, responsibilities, and contributions are more fluid and interdependent [17]. Leaders must ensure that AI systems are effectively embedded into team processes, supporting rather than disrupting collaboration. This involves clarifying how tasks are allocated, how information flows between human and artificial actors, and how decisions are collectively shaped. At the same time, leaders must address relational dynamics within hybrid teams, including trust, communication, and shared understanding. The presence of AI can alter these dynamics by introducing new forms of interaction and influencing how authority and expertise are perceived. Effective leadership therefore requires maintaining cohesion while enabling productive engagement with AI as an active participant in team processes.

Organizational-Level Leadership and System Design

At the organizational level, complementarity is reflected in the design of systems, structures, and processes that govern human-AI interaction. Leadership extends beyond direct supervision and becomes a matter of shaping the broader context in which collaboration takes place. This includes designing workflows that integrate AI into core operations, establishing governance mechanisms for responsible AI use, and

ensuring alignment between technological capabilities and organizational strategy [2]. Leaders are responsible for creating an environment in which human and artificial intelligence can function as complementary components of a unified system. This requires balancing efficiency with adaptability, as well as standardization with flexibility. Organizational-level leadership also involves addressing issues of accountability and transparency, particularly in situations where decision-making is distributed across human and AI actors. As a result, leadership becomes closely linked to system design, where the effectiveness of complementarity depends on how well organizational structures support coordination, learning, and continuous adjustment.

Across these levels, the framework highlights that leadership in human-AI complementarity is inherently integrative. Each level addresses a specific dimension of interaction, yet none can be fully effective in isolation. Cognitive engagement at the individual level, collaborative processes at the team level, and system design at the organizational level must be aligned to ensure consistent and effective human-AI collaboration. This multi-level perspective provides a structured foundation for understanding how leadership can operationalize complementarity in practice and underscores the growing importance of capabilities that enable leaders to connect these dimensions in technology-mediated environments.

Conclusion and prospects for future research. The article has developed a multi-level framework for understanding leadership in the context of human-AI complementarity. The proposed framework conceptualizes leadership as an integrative capability that aligns human and artificial intelligence across

individual, team, and organizational levels. The analysis demonstrates that leadership effectiveness in AI-enabled environments depends not only on technological capabilities or individual competencies, but also on the ability to coordinate cognitive, collaborative, and organizational processes across interconnected levels of analysis.

The findings further suggest that leadership transformation in the context of human-AI complementarity is characterized by a shift in the role of leaders from serving primarily as sources of expertise, judgment, and direction toward creating conditions that enable the effective alignment of human and AI capabilities in pursuit of organizational goals. As human and artificial intelligence become increasingly interconnected, leadership effectiveness depends not solely on the leader's individual expertise but increasingly on the ability to facilitate the productive combination of complementary capabilities across multiple organizational levels. In this context, leaders assume a pivotal role in fostering collective learning, strengthening coordination across organizational levels, and supporting the continuous adaptation of socio-technical systems. Consequently, leadership emerges as a capability for orchestrating human-AI complementarity and transforming it into sustainable organizational value. Future research should focus on the empirical validation of the proposed framework across different organizational contexts. Particular attention may be devoted to examining the capabilities and mechanisms that facilitate human-AI complementarity, as well as the contextual factors that influence its effectiveness in practice.

References:

1. Dellermann, D., Ebel, P., Söllner, M., & Leimeister, J. M. (2019). Hybrid intelligence. *Business & Information Systems Engineering*, 61 (5), 637-643. <https://doi.org/10.1007/s12599-019-00595-2>.
2. Brynjolfsson, E., & McAfee, A. (2017). *Machine, platform, crowd: Harnessing our digital future*. W. W. Norton & Company.
3. Deloitte. (2026). 2026 Global Human Capital Trends: From tensions to tipping points: Choosing the human advantage. URL: <https://surl.li/hlizbx>.
4. McKinsey & Company. (2026). *The State of Organizations 2026*. URL: <https://surl.li/rjlhgh>.
5. Davenport, T. H., & Kirby, J. (2016). *Only humans need apply: Winners and losers in the age of smart machines*. Harper Business.
6. Raisch, S., & Krakowski, S. (2021). Artificial intelligence and management: The automation-augmentation paradox. *Academy of Management Review*, 46 (1), 192-210. <https://doi.org/10.5465/amr.2018.0072>.
7. Westerman, G., Bonnet, D., & McAfee, A. (2014). *Leading digital: Turning technology into business transformation*. Harvard Business Review Press.
8. Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business Horizons*, 61 (4), 577-586. <https://doi.org/10.1016/j.bushor.2018.03.007>.
9. Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D., & Buckley, N. (2015). *Strategy, not technology, drives digital transformation*. MIT Sloan Management Review.
10. Choudhary, V., Marchetti, A., Shrestha, Y. R., & Puranam, P. (2025). Human-AI Ensembles: When Can They Work? *Journal of Management*, 51(2), 536-569. <https://doi.org/10.1177/01492063231194968>.
11. Hemmer, P., Schemmer, M., Vössing, M., & Kühl, N. Human-AI Complementarity in Hybrid Intelligence Systems: A Structured Literature Review (2021). PACIS 2021 Proceedings. 78. <https://aisel.aisnet.org/pacis2021/78>.
12. Hemmer, P., Schemmer, M., Kühl, N., Vössing, M., & Satzger, G. (2025). Complementarity in human-AI collaboration: concept, sources, and evidence. *European Journal of Information Systems*, 34 (6), 979-1002. <https://doi.org/10.1080/0960085X.2025.2475962>.
13. Leszczyński, G., Gaczek, P., & Munzel, A. Human-Ai Collaboration in Managerial Decision-Making: A Taxonomy of Adoption Mindsets and Strategic Integration. Available at SSRN: <http://dx.doi.org/10.2139/ssrn.5378422>.

14. Ulrich, D., Kawai, L. A., & Burns, E. W. (2024). Leadership Code 4.0: An Evidence-Based View of Effective Leadership. The RBL Group.
15. Whitehead, J., Hashim, M., Issam, T., & Gilani, S. A. (2025). Strategic Leadership 5.0: Reality or Illusion? Journal of the Knowledge Economy. <https://doi.org/10.1007/s13132-025-02785-8>.
16. Oberer, B., & Erkollar, A. (2018). Leadership 4.0: Digital Leaders in the Age of Industry 4.0. International Journal of Organizational Leadership, 7, 404-412. <https://doi.org/10.33844/ijol.2018.60332>.
17. Kellogg, K. C., Valentine, M. A., & Christin, A. (2020). Algorithms at work: The new contested terrain of control. Academy of Management Annals, 14 (1), 366-410. <https://doi.org/10.5465/annals.2018.0174>.
18. An, M., Lin, J., & Luo, X. (R.). (2024). The impact of human AI skills on organizational innovation: The moderating role of digital organizational culture. Journal of Business Research, 182, Article 114786. <https://doi.org/10.1016/j.jbusres.2024.114786>.
19. Warner-Söderholm, G., & Kuoppamäki, M. (2025). Beyond Industry 5.0: Leadership 5.0 – Driving Future-Ready Organizations. Businesses, 5 (4), 56. <https://doi.org/10.3390/businesses5040056>.
20. Uhl-Bien, M., & Arena, M. (2018). Leadership for organizational adaptability: A theoretical synthesis and integrative framework. The Leadership Quarterly, 29 (1), 89-104. <https://doi.org/10.1016/j.leaqua.2017.12.009>.



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