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Systemic Intelligence in Management and Entrepreneurship: An Integral Analysis of Knowledge, Human Capital, Technology, and Sustainable Transformation

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Abstract

This article develops an integral and systemic analysis of contemporary management and entrepreneurship, interpreting them as interconnected processes of knowledge creation, human capital development, technological transformation, and sustainable governance. Departing from reductionist approaches that isolate economic efficiency, innovation, or technology as autonomous drivers of organisational success, the study proposes a holistic framework in which management is understood as a dynamic system of cognitive, anthropological, and ethical relations.

The paper argues that knowledge is not merely an informational resource but a relational and interpretive process embedded in human interaction, organisational culture, and institutional contexts. Human capital, entrepreneurship, and technological innovation—particularly artificial intelligence and machine learning—are analysed as mutually conditioning dimensions of systemic intelligence, shaping both value creation and value appropriation within organisations. At the same time, macroeconomic and institutional factors, such as governance quality, corruption, financial stability, and policy modelling, are shown to exert a decisive influence on organisational behaviour and long-term development trajectories.

Special attention is devoted to the role of sustainability and energy transition as expressions of systemic transformation rather than isolated policy goals. The article conceptualises sustainable growth as a multi-level process integrating organisational learning, technological adaptation, ethical responsibility, and socio-economic resilience, particularly in emerging and transforming economies.

By synthesising insights from management studies, entrepreneurship research, human resource management, artificial intelligence, and sustainability studies, the paper advances the concept of systemic intelligence as a unifying analytical category. This perspective contributes to contemporary management theory by offering an integrative framework capable of explaining complex organisational phenomena across micro-, meso-, and macro-levels of analysis.

Keywords: *systemic intelligence; management systems; human capital; knowledge management; entrepreneurship; artificial intelligence; technological transformation; value creation; sustainability; energy transition; governance*

INTRODUCTION

Contemporary management research increasingly acknowledges that organisations operate as complex systems rather than linear arrangements governed by isolated economic variables. Traditional models centred on efficiency, capital accumulation, or technological input have proven insufficient for explaining organisational performance under conditions of uncertainty, institutional volatility, and accelerated technological change. As a result, recent scholarship has shifted toward systemic perspectives integrating human capital, knowledge processes, entrepreneurship, technology, and governance into unified analytical frameworks.

Within this systemic turn, human resource management and knowledge management have been identified as foundational components of organisational development. Research

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demonstrates that innovativeness emerges not as an automatic consequence of technological investment, but as a result of organisational systems capable of mobilising competencies, learning mechanisms, and internal communication structures (Staniewski, 2011). Complementary analyses of human resource practices supporting knowledge management further indicate that organisational effectiveness depends on the alignment between human capital policies and knowledge-sharing processes (Staniewski, 2007). These findings position knowledge and human resources as mutually reinforcing elements of organisational intelligence.

Entrepreneurship research has followed a similar evolution, moving away from individualistic explanations toward relational and system-oriented approaches. Empirical studies on the entrepreneurship of Polish students reveal that entrepreneurial intentions and capabilities are shaped by socioeconomic conditions, educational environments, and institutional contexts rather than by personality traits alone (Staniewski & Szopiński, 2013). In parallel, research on family communication and entrepreneurial success demonstrates that entrepreneurial self-efficacy mediates the relationship between relational environments and entrepreneurial outcomes (Staniewski, Awruk, Leonardi, & Słomski, 2024). Entrepreneurship thus appears as a socially embedded process rooted in interconnected micro- and meso-level systems.

At the macroeconomic level, institutional quality and governance structures constitute critical determinants of organisational and entrepreneurial behaviour. Empirical investigations into the effect of corruption on domestic savings in developing economies show that institutional distortions weaken financial accumulation and undermine long-term development trajectories (Abu & Staniewski, 2022). These findings underline the necessity of incorporating governance variables into systemic analyses of management and entrepreneurship.

Technological transformation, particularly the diffusion of artificial intelligence and machine learning, has further intensified the systemic nature of contemporary management. Studies analysing value creation and appropriation in start-ups using machine learning demonstrate that competitive advantage depends on specific configurations of technological capability, managerial competence, and organisational structure rather than on technology alone (Costa-Climent, Navarrete, Haftor, & Staniewski, 2024). Similarly, research on AI-based policy modelling shows that artificial intelligence increasingly reshapes not only organisational decision-making but also public governance and economic policy environments (Estrada, Park, & Staniewski, 2023).

Finally, sustainability and energy transition have emerged as central dimensions linking organisational strategy with macroeconomic and environmental systems. Empirical analyses of energy-intensive growth paths indicate that renewable energy adoption combined with open market conditions supports sustainable development, particularly in developing economies facing structural constraints (Bekun et al., 2025). Sustainability thus appears not as an external constraint, but as an integral element of systemic transformation.

Despite the breadth of research across these domains, the literature remains fragmented. Human resource management, entrepreneurship, artificial intelligence, governance, and sustainability are frequently analysed in isolation, limiting their explanatory power with respect to complex organisational realities. This article addresses this gap by advancing the concept of systemic intelligence as an integrative framework for contemporary management. The objective of the study is to demonstrate how knowledge, human capital, entrepreneurship, technological transformation, and governance interact within multi-level systems to shape organisational performance and long-term development trajectories.

Systemic Foundations of Knowledge and Human Capital in Organisations

From a systemic perspective, organisations function as knowledge-based and human-centred systems in which value creation emerges from the interaction between people, structures, and shared cognitive frameworks. Knowledge and human capital do not operate as independent resources; instead, they form an integrated subsystem that determines an organisation's capacity for learning, adaptation, and long-term development. This approach challenges instrumental views of management that reduce human resources to cost factors or knowledge to codified information detached from human agency.

Research in human resource management provides strong empirical support for this systemic interpretation. Analyses of human resource management in the context of innovativeness demonstrate that innovation results from organisational configurations enabling learning, creativity, and effective utilisation of human competencies rather than from technological inputs alone (Staniewski, 2011). When human capital is embedded in supportive organisational cultures and communication systems, it becomes a carrier of organisational intelligence capable of generating sustainable competitive advantage.

The systemic role of human capital becomes even more evident when human resource management is analysed in relation to knowledge management. Studies focusing on the elements of human resource management supporting knowledge processes indicate that recruitment, training, motivation, and performance appraisal must be aligned with mechanisms of knowledge creation and sharing to enable organisational learning (Staniewski, 2007). In such configurations, individual knowledge is transformed into collective capability; where misalignment occurs, knowledge remains fragmented and underutilised.

At the organisational level, knowledge management should therefore be understood not as a technical or informational function, but as a socially embedded process. Knowledge is created through interaction, interpretation, and cooperation,

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which makes human capital development a prerequisite for effective knowledge systems. This insight is reinforced by broader theoretical work linking human resource management with knowledge management as mutually dependent dimensions of organisational development (Staniewski, 2008). From this perspective, organisations that invest in technology without parallel investment in people and learning structures rarely achieve long-term effectiveness.

The institutional and macro-organisational context further shapes the relationship between knowledge and human capital. Comparative analyses of human resource architectures in European Union new member states show that organisational practices are influenced by historical legacies, labour market institutions, and governance frameworks, which affect how knowledge is accumulated, retained, and transferred within firms (Staniewski, 2005). These findings demonstrate that human capital systems are embedded within broader institutional environments and cannot be designed independently of them.

The systemic nature of knowledge and human capital is also evident in entrepreneurial contexts. Entrepreneurial activity relies on the ability to recombine existing knowledge resources drawn from education, experience, and social networks. Empirical research on the entrepreneurship of Polish students confirms that entrepreneurial capabilities are shaped by socioeconomic conditions and educational environments rather than by individual motivation alone (Staniewski & Szopiński, 2013). This supports the view that entrepreneurial human capital is socially embedded and systemically conditioned.

Communication processes constitute a critical mechanism linking human capital and knowledge systems. Research on family communication and entrepreneurial success demonstrates that communication patterns influence cognitive and motivational resources that later translate into organisational behaviour and performance (Staniewski, Awruk, Leonardi, & Słomski, 2024). These findings highlight that the foundations of organisational knowledge systems often extend beyond formal organisational boundaries and originate in earlier relational environments.

Taken together, these insights support a systemic interpretation of knowledge and human capital as co-evolving components of organisational intelligence. Knowledge emerges through human action, while human capital develops through participation in learning and communication systems embedded in organisational and institutional contexts. Effective management, therefore, consists not in optimising isolated resources, but in designing coherent systems that integrate people, knowledge, and organisational structures.

This systemic foundation provides the conceptual basis for analysing entrepreneurship, technological transformation, and sustainability as higher-order manifestations of organisational intelligence. Understanding how knowledge and human capital interact within interconnected systems is essential for explaining contemporary organisational dynamics and development trajectories.

Entrepreneurship as a Systemic and Relational Process

Entrepreneurship, when analysed from a systemic perspective, cannot be reduced to individual initiative, personality traits, or isolated market opportunities. Instead, it emerges as a relational process embedded in interdependent social, economic, and institutional systems that jointly shape entrepreneurial behaviour and outcomes. Entrepreneurs operate within networks of relationships that influence access to resources, interpretation of opportunities, and the capacity to transform ideas into sustainable economic activity.

Empirical research supports the view that entrepreneurial success results from complex configurations of interacting factors rather than linear causal mechanisms. Studies adopting a systems approach to entrepreneurial success demonstrate that effectiveness in entrepreneurial activity depends on the alignment between individual competencies, family environments, organisational support structures, and broader institutional conditions (Staniewski & Awruk, 2018). From this perspective, entrepreneurship represents an emergent property of interacting subsystems rather than a direct function of individual effort.

A key relational dimension of entrepreneurship concerns the role of family communication and early socialisation processes. Entrepreneurial cognition, motivation, and resilience are shaped long before formal business activity begins, through communication patterns, value transmission, and relational support systems. Empirical validation of the Entrepreneur's Family Communication Questionnaire confirms that family communication constitutes a measurable and significant factor influencing entrepreneurial attitudes and behavioural dispositions (Staniewski, Awruk, & Leonardi, 2023). These findings highlight the continuity between micro-social systems and later organisational action.

The systemic character of entrepreneurship is further reinforced by macro-institutional conditions. Governance quality and institutional trust play a decisive role in shaping entrepreneurial incentives and constraints. Empirical investigations into the effect of corruption on domestic savings in developing economies show that institutional distortions weaken financial accumulation and reduce the availability of resources for entrepreneurial investment (Abu & Staniewski, 2022). In such contexts, entrepreneurship is constrained not by individual capability alone, but by systemic dysfunctions embedded in governance structures.

Macroeconomic stability constitutes another critical subsystem influencing entrepreneurial processes. Stable financial environments enable long-term planning, risk assessment, and intergenerational continuity of entrepreneurial activity, whereas instability increases uncertainty and discourages investment. From a systemic standpoint, entrepreneurship depends on the coherence of economic, institutional, and social systems that collectively shape opportunity structures.

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Ethical and normative dimensions further underscore the relational nature of entrepreneurship. Entrepreneurial decisions are embedded in value systems that influence strategic choices, stakeholder relations, and legitimacy within social and institutional contexts. Entrepreneurship therefore functions not merely as an economic mechanism, but as a socially situated practice shaped by norms, expectations, and relational accountability.

Taken together, these insights support an understanding of entrepreneurship as a systemic and relational process in which individual agency is inseparable from family systems, institutional frameworks, and macroeconomic conditions. Entrepreneurial outcomes arise from the interaction—and alignment—of these subsystems rather than from isolated individual characteristics.

Understanding entrepreneurship in this way provides a crucial bridge between human capital and technological transformation. Entrepreneurs act as carriers of systemic change, translating knowledge, values, and relational resources into organisational innovation. Consequently, entrepreneurship constitutes a central mechanism through which systemic intelligence is operationalised within organisations and economies.

Technological Transformation, Artificial Intelligence, and Value Creation

Technological transformation has become a central driver of organisational change, fundamentally reshaping how value is created, appropriated, and sustained. Unlike earlier stages of digitalisation focused on automation and efficiency, the current wave driven by artificial intelligence and machine learning penetrates the cognitive core of organisations. From a systemic perspective, technology operates not as an external tool but as an integral component of organisational intelligence, interacting with human capital, governance structures, and strategic orientation.

Empirical research on start-ups using machine learning demonstrates that value creation does not result from technological sophistication alone. Analyses employing fuzzy-set qualitative comparative analysis show that competitive advantage emerges from specific configurations combining technological capabilities, managerial competencies, and organisational arrangements (Costa-Climent, Navarrete, Haftor, & Staniewski, 2024). These findings confirm that artificial intelligence amplifies existing organisational structures rather than substituting for coherent management systems.

Beyond value creation, artificial intelligence also reshapes mechanisms of value appropriation by transforming decision-making processes, organisational boundaries, and control structures. Research on intelligent transformation in business and technology indicates that AI-driven systems redistribute authority between human actors and algorithmic tools, requiring new governance models capable of balancing efficiency, accountability, and ethical responsibility (Costa-Climent, Haftor, & Staniewski, 2024). Value appropriation thus depends on how effectively organisations integrate technological systems with human judgement and institutional norms.

Artificial intelligence increasingly extends its influence beyond organisational boundaries into the domain of public governance and economic policy. Studies on AI-based policy modelling demonstrate that advanced analytical tools enhance the capacity of public institutions to simulate complex economic scenarios, assess policy alternatives, and manage systemic risk (Estrada, Park, & Staniewski, 2023). This indicates that technological transformation operates simultaneously at organisational and institutional levels, shaping the environments in which firms create and appropriate value.

From a systemic viewpoint, technological transformation must therefore be analysed as a socio-technical process rather than a purely technological one. Artificial intelligence interacts with organisational culture, human resource practices, and governance frameworks, producing outcomes that depend on the coherence of the overall system. Where organisational and institutional systems are aligned, AI enhances learning, coordination, and adaptability; where misalignment prevails, technology may intensify fragmentation and strategic instability (Estrada, Park, & Staniewski, 2023).

Recent integrative work on intelligent transformation further reinforces this interpretation by emphasising that successful navigation of the AI revolution requires the alignment of technology with human capital development, organisational learning, and strategic governance (Costa-Climent, Haftor, & Staniewski, 2024). Artificial intelligence thus functions as a catalyst within broader systems of organisational intelligence rather than as an autonomous source of competitive advantage.

Taken together, these insights demonstrate that technological transformation and artificial intelligence should be understood as systemic phenomena embedded in organisational and institutional contexts. Value creation and appropriation depend on the interaction between technological capability, human capital, and governance coherence. This systemic understanding provides a bridge between technological innovation and broader challenges related to sustainability and long-term development.

Sustainability, Energy Transition, and Systemic Governance

Sustainability and energy transition constitute advanced stages of systemic transformation in contemporary management and economic governance. Rather than functioning as isolated environmental objectives, they reflect structural changes in how organisations, markets, and institutions coordinate long-term value creation. From a systemic perspective, sustainability emerges at the intersection of technological capability, organisational intelligence, institutional quality, and governance coherence.

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Empirical research on energy-intensive growth patterns demonstrates that traditional development trajectories based on fossil fuel dependence generate increasing economic and environmental constraints. Analyses of developing economies indicate that renewable energy deployment combined with open market conditions enables more resilient transition pathways, supporting long-term growth while reducing systemic vulnerability to external shocks (Bekun et al., 2025). These findings suggest that energy transition should be interpreted as a systemic reconfiguration of economic structures rather than a sector-specific adjustment.

The governance dimension of sustainability is equally critical. Effective sustainability transitions require institutional frameworks capable of coordinating long-term investments, aligning incentives, and maintaining trust among economic actors. Editorial analyses focusing on innovation, management, and governance for sustainable growth emphasise that sustainability cannot be achieved through isolated managerial practices, but demands integrative governance mechanisms spanning organisational, sectoral, and institutional levels (Alonso Dos Santos, Huertas González-Serrano, & Staniewski, 2023). Sustainability thus appears primarily as a governance challenge rather than a purely technological one.

At the organisational level, sustainability-oriented strategies depend on the alignment of human capital systems with long-term development objectives. Research on human resources architecture in European Union new member countries demonstrates that organisational practices are shaped by institutional legacies, labour market structures, and governance frameworks, which significantly influence the capacity of organisations to adapt to sustainability demands (Staniewski, 2005). These findings highlight that sustainability transitions are conditioned by the systemic coherence of human resource architectures rather than by isolated policy interventions.

Energy transition further exposes the interdependence between technological change and institutional arrangements. The adoption of renewable energy technologies alters market dynamics, investment horizons, and regulatory requirements, increasing the complexity of governance systems. From a systemic standpoint, sustainability functions as a catalyst revealing misalignments between economic incentives, technological trajectories, and institutional capacities that must be addressed through coordinated governance responses.

Recent integrative research on intelligent transformation underscores that sustainability-oriented governance increasingly depends on the ability to integrate technological innovation with organisational learning and human capital development. The effective navigation of complex transitions—such as energy system transformation—requires systemic intelligence capable of coordinating technological, organisational, and institutional subsystems within a coherent strategic framework (Costa-Climent, Haftor, & Staniewski, 2024). Sustainability thus becomes inseparable from broader processes of organisational and institutional intelligence.

Taken together, these insights support an interpretation of sustainability and energy transition as dynamic governance processes rather than static end states. Sustainable development emerges from the capacity of systems to integrate energy policy, organisational intelligence, human capital, and institutional coordination into long-term strategies. Energy transition, in this sense, represents both a challenge and an opportunity for developing systemic intelligence across organisational and economic domains.

Synthesis and Conclusions: Systemic Intelligence as an Integrative Framework for Contemporary Management

The analyses presented in this article demonstrate that contemporary management must be understood as the governance of complex, interdependent systems rather than as the optimisation of isolated organisational variables. Across all examined dimensions—human capital, entrepreneurship, technological transformation, and sustainability—the decisive factor shaping long-term organisational performance is the degree of systemic coherence achieved between knowledge processes, institutional arrangements, and governance mechanisms. The concept of systemic intelligence provides a unifying framework capable of integrating these dimensions into a single analytical perspective.

At the organisational level, systemic intelligence is grounded in the alignment of human resource management with knowledge management processes. Research linking human resources with knowledge management emphasises that organisational learning and adaptability depend on the coherence between people-oriented practices and knowledge-sharing mechanisms rather than on technological tools alone (Staniewski, 2008; Staniewski, 2010). These insights confirm that organisations capable of integrating human capital development with knowledge governance are better positioned to sustain long-term value creation.

This systemic logic extends beyond organisational boundaries into macroeconomic and institutional contexts. Analyses of pension systems demonstrate that inflation dynamics and exchange rate volatility significantly affect the real value of long-term financial arrangements, thereby shaping intergenerational stability and strategic planning horizons (Ruiz Estrada, Khan, Staniewski, & Mansor, 2022). From a systemic perspective, financial stability constitutes a critical background condition enabling both organisational investment and sustainable development, reinforcing the interdependence between macroeconomic governance and organisational intelligence (Ruiz Estrada et al., 2022).

Entrepreneurship further illustrates the relational and systemic nature of organisational intelligence. Empirical validation of the Entrepreneur's Family Communication Questionnaire confirms that entrepreneurial cognition and behaviour are deeply influenced by relational environments formed prior to formal organisational engagement (Staniewski, Awruk, & Leonardi, 2023). These relational foundations interact with organisational and institutional systems, shaping

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entrepreneurial effectiveness and reinforcing the view that entrepreneurship is an emergent property of interconnected social subsystems rather than an isolated individual activity.

Technological transformation adds another layer to systemic intelligence by intensifying interdependencies between human judgement, organisational learning, and governance structures. Integrative research on intelligent transformation demonstrates that the successful navigation of the AI revolution requires the alignment of advanced technologies with human capital development and strategic governance frameworks (Costa-Climent, Haftor, & Staniewski, 2024). When such alignment is absent, technological innovation risks amplifying fragmentation rather than generating sustainable value (Costa-Climent et al., 2024).

From a governance perspective, sustainability emerges as the most comprehensive test of systemic intelligence. Editorial analyses on innovation, management, and governance for sustainable growth emphasise that long-term development depends on integrative approaches capable of coordinating organisational, technological, and institutional subsystems within coherent governance architectures (Alonso Dos Santos, Huertas González-Serrano, & Staniewski, 2023). This insight is reinforced by comparative research on human resources architecture in European Union new member countries, which shows that institutional legacies and governance frameworks critically shape organisational adaptability and long-term resilience (Staniewski, 2005).

Taken together, these findings support the central conclusion of this article: systemic intelligence constitutes a dynamic capability enabling organisations and institutions to manage complexity, uncertainty, and long-term transformation. It is expressed through the coherence of human capital systems, knowledge governance, entrepreneurial processes, technological integration, and institutional stability. Rather than representing a static managerial attribute, systemic intelligence emerges through continuous learning, coordination, and governance alignment across multiple levels of analysis.

In conclusion, contemporary management theory and practice must move beyond reductionist models toward integrative frameworks capable of capturing systemic interdependencies. By conceptualising management as the governance of interconnected socio-economic systems, the notion of systemic intelligence offers both explanatory power and normative guidance for building more resilient, adaptive, and sustainable organisations in an increasingly complex global environment.

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