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Managerial Competence and AI-Driven Technological Innovation: Catalysts For Sustainable Economic Growth

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Abstract: *This study examines the interdependent roles of managerial competence and artificial intelligence (AI)–driven innovation in fostering sustainable economic growth within contemporary organisations. Drawing on human capital, dynamic capabilities, and innovation management perspectives, it conceptualizes managerial competence as a multidimensional capability encompassing strategic insight, digital proficiency, ethical judgment, adaptive leadership, and data-informed decision making. The study argues that the economic value derived from AI technologies such as big data analytics and the Internet of Things is largely shaped by managerial choices regarding adoption, integration, and governance. It also highlights contextual, technical, ethical, and workforce-related challenges. A conceptual framework is proposed to illustrate how managerial competence and AI-enabled innovation interact to enhance operational efficiency, innovation performance, and long-term competitive sustainability. The article also identifies critical constraints, including methodological limitations, contextual differences across industries and institutional settings, technical complexities, ethical concerns, and workforce transformation challenges. In response, a conceptual model is advanced to illustrate the reciprocal and reinforcing interaction between managerial competence and AI-enabled innovation. This framework demonstrates how effective managerial capabilities amplify the strategic impact of AI technologies, thereby enhancing operational efficiency, innovation capacity, long-term competitiveness, and responsible resource stewardship.*

Key words: Managerial Competence, AI, AI-Driven Technological Innovation, Economic Growth

Introduction

The contemporary global economy is characterized by accelerated digitalization, structural volatility, and increasing systemic interdependence, conditions that have repositioned sustainable economic growth as a strategic imperative for governments, corporations, and multilateral institutions. Traditional determinants of growth most notably capital accumulation and labor expansion remain relevant; however, they are increasingly complemented, and in some cases superseded, by intangible drivers such as knowledge creation, technological innovation, and leadership effectiveness. In the twenty-first century, economic sustainability extends beyond aggregate output indicators such as gross domestic product (GDP) to encompass adaptive resilience, social inclusiveness, ecological responsibility, and the capacity to generate long-term stakeholder value. Within this evolving paradigm, the dynamic interplay between managerial capability and advanced digital technologies particularly artificial intelligence (AI) has emerged as a critical domain of scholarly and strategic concern.

Artificial intelligence, broadly understood to include machine learning algorithms, predictive modelling systems, natural language processing applications, and autonomous decision architectures, is reshaping production systems, service delivery models, and institutional governance across sectors such as manufacturing, healthcare, finance, logistics, and public administration. Empirical evidence indicates that countries and firms that invest strategically in AI infrastructure, cultivate innovation ecosystems, and implement coherent digital transformation policies tend to record superior productivity growth and enhanced economic performance (Huy *et al*., 2024). These findings underscore AI’s transformative capacity; however, they also raise important questions regarding the conditions under which technological potential translates into sustainable and inclusive economic outcomes.

Central to this translation process is managerial competence. Managerial competence may be conceptualized as a composite of strategic acumen, analytical reasoning, digital literacy, interpersonal effectiveness, and ethical discernment that enables leaders to operate effectively within complex and uncertain environments. Competent managers do not merely authorize technological investments; they interpret technological possibilities, align them with organizational purpose, coordinate cross-functional integration, and embed innovation within sustainable development objectives. In this regard, managerial actors function as strategic intermediaries who convert technical capability into socio-economic value. Recent empirical investigations demonstrate that leadership proficiency in AI-related knowledge significantly strengthens organizational innovation capacity and sustainability-oriented practices, thereby moderating the relationship between technological adoption and performance outcomes (Al Halbusi *et al*., 2025).

Moreover, the integration of managerial competence with AI systems has profound implications for organizational transformation and governance. Leadership attributes such as strategic foresight, change management capability, ethical oversight, and data-driven decision competence enhance institutional agility and reduce resistance during digital modernization initiatives. Evidence suggests that organizations led by digitally proficient managers experience more effective innovation processes and improved performance during technology-driven transitions (Hasan and Haque, 2024; Maksudul and Rezaul, 2024). Beyond internal performance metrics, managerial expertise in AI contributes to broader developmental objectives. Leaders equipped with advanced digital capabilities are better positioned to foster disruptive yet responsible innovations, including circular production models and sustainability-centered value chains that align with contemporary growth paradigms (Nature Scientific Reports, 2025).

Against this backdrop, the theme “Managerial Competence and AI-Driven Technological Innovation as Catalysts for Sustainable Economic Growth” addresses a critical intersection of leadership theory, technological innovation scholarship, and development economics. It recognizes that sustainable economic advancement in the digital era cannot be attributed exclusively to technological sophistication or to managerial aptitude in isolation. Rather, enduring growth emerges from the reciprocal and reinforcing interaction between capable leadership and intelligent technological systems. Appreciating this interdependence is essential for the formulation of public policies, corporate strategies, and educational frameworks that equip institutions and leaders to harness AI in a manner that is economically productive, socially inclusive, ethically grounded, and environmentally sustainable.

Literature Review

Managerial Competence

The professionalization of management is fundamentally aimed at enhancing organizational effectiveness and operational efficiency by ensuring managers possess high levels of skill, knowledge, and practical expertise. In contemporary organizations, managers are increasingly regarded not merely as administrators but as visionary leaders and innovators who must continuously expand their knowledge and adapt to evolving professional demands. Ivanova (2006) emphasizes that managers are carriers of intellectual capital, whose competencies directly influence organizational performance, competitive positioning, and market appeal. In this context, managers are expected to anticipate trends, respond proactively to challenges, and execute strategies today that others may only conceptualize for the future.

Komendant and Mikhailov (2001) argue that management is both a science and an art, highlighting that effective managerial performance involves resolving organizational problems innovatively, efficiently, and with minimal wastage of resources. Success in this regard is heavily dependent on both the personal qualities of the manager and the level of professional training they have received. Competence, in its broadest sense, is understood as the integration of knowledge, skills, and abilities required for effective performance (Bhardwaj, 2013). Research further underscores that competencies constitute clusters of interrelated knowledge, skills, behaviors, and attitudes that correlate with high performance and can be enhanced through structured training and professional development programs (Berge *et al*., 2002).

While definitions of competence vary, they typically converge around two dimensions. The first, **characteristic-based competence**, refers to inherent capacities linked to an individual’s traits or disposition. The second, **capacity-based competence**, focuses on the personal ability to perform specific tasks, encompassing skills, behaviors, knowledge, and functional capabilities. In essence, managerial competence represents a combination of knowledge, skills, abilities, and workplace behaviors that collectively influence both individual and organizational performance outcomes (Martina *et al*., 2012). Asumeng (2014) asserts that behavioral skills and knowledge are strong predictors of organizational success, particularly in contexts where strategic thinking and long-term organizational prosperity are prioritized. Similarly, Martina *et al*. (2012) describe competence as an input-output framework: inputs comprising an individual’s knowledge, skills, attitudes, and values, while outputs are observable behaviors and measurable results, which in turn reflect the organization’s standing in the market and its competitive advantage.

Thus, from a functional perspective, managerial competence is a complex amalgam of professional expertise and personal attributes that manifest during managerial activities. It encompasses technical knowledge, decision-making skills, leadership qualities, values, motives, and evaluative judgment (Luhova *et al*., 2021). Given the continuous evolution of business environments, managerial competence must be periodically updated and refined, underscoring the importance of fostering managers’ motivation for self-development. Voloshko (2011) conceptualizes managerial competence as an integrative personality trait that combines positional authority, specialized knowledge, and skills, reflecting both the willingness and the ability to execute professional duties effectively while solving organizational and managerial challenges.

Further, Zakharchenko and Medvedeva (2012) define managerial competence as a professional characteristic that integrates managerial knowledge, skills, and abilities, enabling independent and effective performance in organizational contexts. Lutsky (2012) adds that managerial competence is a multidimensional formation encompassing theoretical understanding, practical skills, professional values, and personal attributes, which collectively guide managerial behavior and decision-making. A critical synthesis of these perspectives indicates that managerial competence should be understood as a dynamic, professional-personal construct that enables managers to perform their functions at normative standards while balancing professional obligations with personal values and motivations. It is composed of two interrelated dimensions:

1. Functional Competence: This encompasses the knowledge, skills, and abilities necessary to perform managerial tasks effectively, including planning, decision-making, problem-solving, and strategic execution.
2. Personal Competence: This dimension includes the manager's values, motivations, interests, attitudes, goals, and self-awareness. It reflects how an individual integrates personal attributes with professional responsibilities, facilitating effective self-assessment and alignment with organizational objectives.

Overall, managerial competence is both a measurable and developable attribute that integrates functional expertise and personal qualities to ensure high-performance management. It serves as a key determinant of organizational effectiveness, adaptability, and sustained competitive advantage, particularly in complex and rapidly evolving business environments.

AI-Driven Technological Innovation

Artificial intelligence (AI) has witnessed remarkable advancements in recent years, particularly through the development of sophisticated machine learning techniques such as deep learning and generative adversarial networks. While these methods represent significant progress, their underlying foundation neural networks has been explored for decades. The acceleration of AI capabilities has been largely facilitated by enhanced computing power and the unprecedented availability of large-scale data, often referred to as big data. Indeed, the emergence and expansion of big data are intrinsically linked to advancements in AI, as the ability to process vast datasets enables more accurate predictions, pattern recognition, and autonomous decision-making.

Moreover, AI's development is increasingly intertwined with the Internet of Things (IoT), which provides a framework for connecting physical devices, sensors, and equipment to the internet, enabling real-time data collection and analysis. IoT-enabled systems have led to practical applications such as intelligent home assistants, autonomous vehicles, and industrial automation systems. Together, AI, big data, and IoT create a mutually reinforcing ecosystem, where AI interprets and derives actionable insights from massive, continuously generated data streams.

At its core, artificial intelligence comprises software systems designed to replicate tasks traditionally requiring human intelligence. These systems employ techniques such as machine learning, deep learning, predictive analytics, and reinforcement learning to process large volumes of data and generate insights that enhance decision-making, problem-solving, and operational efficiency. AI applications span image and text recognition, interactive human-computer interfaces, predictive monitoring of equipment, and data mining across diverse organizational processes. Supporting technologies, including fuzzy logic, genetic algorithms, and mathematical modeling, further enhance AI's capabilities in automating complex tasks and generating optimized solutions (Chowdhury, 2024).

Big Data has transformed the manner in which managerial decisions are made. Historically, organizations collected data for specific functional purposes financial accounting systems tracked revenue and expenditures, human resource systems managed employee records, and supply chain systems monitored inventory and logistics (Kazuyuki, 2018). Big data, however, differs in that it is often collected without a predefined purpose, enabling organizations to uncover new patterns and insights from previously untapped information. For example, Amazon's recommendation engine leverages user purchase histories to predict and suggest books or products likely to interest individual customers. This predictive capability relies on extensive datasets, as larger volumes of data enhance the accuracy of stochastic models that infer user preferences (Mayer-Schonberger & Cukier, 2013).

The Internet of Things (IoT) extends this paradigm by enabling data collection directly from physical objects rather than solely human activity. Devices ranging from household appliances to industrial machinery can transmit data via the internet, creating opportunities for novel services, operational optimization, and business innovations (Kazuyuki, 2018). Implementing IoT solutions requires several key components: unique identification of each device (e.g., through IP addresses), sensing and data acquisition, reliable communication networks, computational analysis, and practical application of insights through services such as predictive maintenance, energy management, or automated industrial operations (Al-Faqaha *et al*., 2015). AI functions as a critical analytical engine within this framework, transforming raw sensor data into actionable intelligence and enabling the broader integration of IoT into organizational and societal applications.

In essence, AI-driven technological innovation is not limited to computational capabilities alone; it encompasses an interconnected ecosystem of data generation, analysis, and practical application. By combining machine intelligence with the

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extensive data flows provided by IoT and big data platforms, organizations can achieve unprecedented levels of efficiency, productivity, and innovation, fundamentally reshaping industries and enabling new paradigms of operation in the digital age.

Relations of these new IT

Artificial intelligence (AI), the Internet of Things (IoT), and big data exist in a highly interdependent and complementary ecosystem, where each component reinforces the capabilities of the others. Beyond the enormous volume of human-generated data available online such as text, images, and transactional records advances in IoT sensor networks have introduced vast streams of data directly from physical objects. Devices ranging from industrial machinery to household appliances continuously generate data that is automatically transmitted and stored. This integration of human- and machine-generated data has substantially enhanced the traditional three dimensions of big data, commonly known as the 3Vs: Volume, Velocity, and Variety (Kazuyuki, 2018). For instance, the daily data output of a manufacturing process can be estimated by multiplying the number of items produced, the steps involved in production, and the granularity of data collection, where granularity refers to the frequency of data capture per unit of time (e.g., per minute). IoT-enabled devices contribute to data streams with such high volume and velocity that they exceed human processing capabilities. Beyond manufacturing, IoT systems in applications like security surveillance cameras and autonomous vehicles generate diverse types of data, including audio, video, and sensor readings, further enriching the data ecosystem.

The availability of this rich and heterogeneous data has driven the development of advanced AI technologies. Data types such as images, audio, and unstructured text are not immediately suitable for direct analysis, necessitating perceptual and recognition technologies. Innovations in computer vision, audio recognition, and natural language processing have emerged to process these complex data formats. Simultaneously, the enormous scale of data supports the evolution of core AI methodologies, including knowledge discovery, data mining, and deep learning, enabling more accurate prediction, pattern recognition, and autonomous decision-making. In effect, IoT provides a continuous stream of real-world data, big data frameworks allow for its storage and structured analysis, and AI technologies convert this information into actionable insights, forming a self-reinforcing cycle of technological advancement (Kazuyuki, 2018).

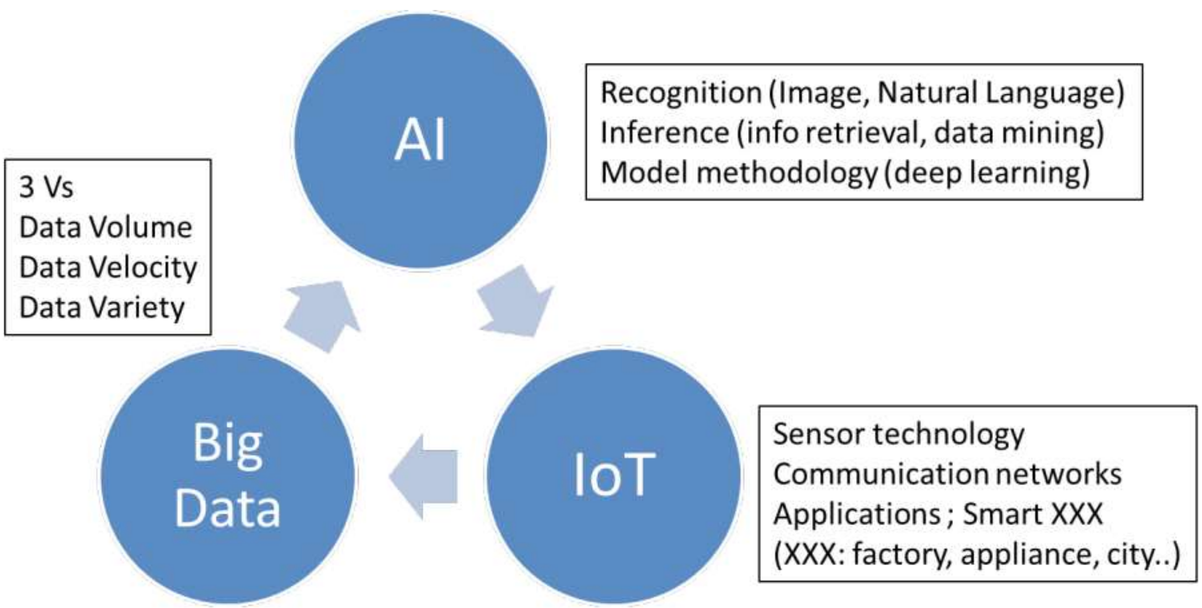

Figure 1: Inter-relationships of AI, IoT and Bigdata
Source: Kazuyuki, 2018

Artificial intelligence (AI), in combination with the Internet of Things (IoT) and big data, forms the technological backbone for a wide range of "smart" services, including smart factories, connected appliances, and smart urban systems. Although massive volumes of data both human-generated and sensor-generated are available on the internet, much of this information is not intentionally collected for specific applications (Kazuyuki, 2018). Instead, IoT devices autonomously capture data as part of their routine operation. This raw information is subsequently processed, interpreted, and transformed into economically valuable services, which explains why systems powered by these technologies are often labeled "smart." Unlike traditional human-led data processing methods, these AI- and IoT-enabled systems allow computers to deliver services with minimal human intervention, producing novel innovations that are largely self-operating yet deliver significant utility to individuals, enterprises, and society (Kazuyuki, 2018).

In the context of e-commerce, AI has been instrumental in driving both operational efficiency and digital transformation across industries. It has played a pivotal role in developing recommendation engines, risk assessment platforms, virtual customer assistants, and search functionalities capable of interpreting audio and visual inputs (Zhang *et al*., 2021; Cheng *et al*., 2021; Libai *et al*., 2020). These AI-powered tools enhance personalization, optimize multi-sided platform interactions, and enable dynamic pricing strategies, contributing directly to revenue growth and user satisfaction (Huang and Rust, 2021). AI chatbots, for instance, are capable of addressing 40–60% of user inquiries in e-commerce environments, reducing dependence on human agents and improving response times and operational efficiency (Cheng *et al*., 2021; Cheng *et al*., 2022). Beyond front-end services, AI applications in backend operations have automated complex logistical processes, including inventory management, demand forecasting, fraud detection in payment systems, and warehouse operations. Studies of AI implementation in Alibaba's fulfillment centers highlighted three critical AI resources data, algorithms, and robotics and three principal functions prediction, planning, and learning that collectively generate value and enhance operational efficiency (Zhang *et al*., 2021).

AI systems also enable real-time adjustments in stock replenishment, dynamic and clearance pricing, and automated shelving, significantly reducing labor intensity while optimizing cost efficiency and profit margins (Lukinskiy *et al*., 2023; Chan *et al*., 2021). The impact of AI-driven technological innovation extends well beyond e-commerce into the broader digital economy. One key application is the development of intelligent products, including advanced software applications, core system software, and hardware platforms. Secondly, AI enables the creation of intelligent application systems that encompass automated design, manufacturing, logistics, and finance processes. Thirdly, AI-driven solutions are increasingly being applied to social governance, including smart cities, intelligent transportation, automated medical systems, AI-assisted education, intelligent courts, and security infrastructures (Zuiderwijk *et al*., 2021; Cheng *et al*., 2020). Empirical studies suggest that public reception of AI in areas such as healthcare is generally positive, reflecting growing trust in AI systems that enhance efficiency and decision-making in critical public services (Gao *et al*., 2020).

In summary, the convergence of AI, IoT, and big data is facilitating a new era of autonomous, intelligent services that transform industrial operations, commercial platforms, and public governance. These innovations not only optimize performance and reduce reliance on human labor but also enable the creation of value-rich, adaptive, and context-aware systems that drive economic growth and social advancement.

The Role of Artificial Intelligence in Driving Economic Growth

Artificial intelligence (AI), a branch of machine learning, operates through the use of neural networks trained on specialized datasets to simulate decision-making and problem-solving processes. The development and effectiveness of AI are underpinned by three key factors: availability of computational resources, quality and quantity of data, and underlying computational theories (Umamaheswari & Valarmathi, 2023). Unlike conventional technologies, AI possesses the unique ability to improve its performance over time in specific tasks due to its learning capabilities. This adaptability allows AI systems to support human decision-making by providing optimized solutions and integrating seamlessly into operational systems.

AI's presence has grown across multiple facets of society, ranging from simple conversational agents to complex automated systems deployed in industrial operations, financial institutions, and government services. Its applications have fundamentally transformed daily life, workflows, and the global economy. Traditionally, AI is understood as the development of computational systems capable of emulating human cognitive functions such as learning, reasoning, problem-solving, and self-improvement (Nanping *et al*., 2024). In the context of economic development, AI has been increasingly recognized as a critical driver of productivity, innovation, and competitiveness across sectors. Research demonstrates AI's capacity to enhance operational efficiency, reduce costs, and improve service delivery. For example, the application of artificial neural networks in power load forecasting has enabled utilities to optimize energy distribution, minimize costs, and maintain reliable supply, illustrating AI's role in economic efficiency (Apsilyam *et al*., 2024).

Limitations and Challenges

Despite the strong potential of AI-driven innovation to accelerate economic growth and enhance managerial effectiveness, several challenges and limitations constrain its full realization.

1. Methodological Limitations: Accurately measuring managerial competence often depends on subjective evaluations or self-reported surveys, which can introduce biases and limit comparability across organizations or regions. Similarly, operational definitions of constructs like "AI-driven technological innovation" are still evolving, making it difficult to distinguish them from broader technological adoption. The absence of standardized evaluation frameworks reduces the generalizability of findings across sectors or countries.

2. Contextual Variability: The effectiveness of AI and managerial competence is highly sensitive to organizational and environmental contexts. Variations in corporate culture, such as risk tolerance, openness to experimentation, and learning orientation, influence how AI tools are adopted and utilized. Additionally, differences in economic conditions, regulatory environments, and digital

infrastructure can create disparities in AI's impact. Emerging economies may face barriers such as insufficient technological infrastructure, restrictive policies, or limited access to data, reducing the replicability of results observed in more developed markets.

3. Technical and Ethical Challenges: Technical constraints including poor data quality, algorithmic bias, and the opaque nature of many AI systems can compromise the accuracy and fairness of AI outputs. Managers lacking technical literacy may struggle to identify these issues or effectively interpret AI insights, which can result in suboptimal or unintended decisions. Ethical considerations, such as data privacy, surveillance risks, and algorithmic discrimination, demand robust governance mechanisms; yet many organizations remain underprepared to address these concerns effectively.

4. Organizational and Workforce Implications: While AI can drive efficiency and innovation, it may also disrupt existing job roles and create employee anxiety or resistance to change. Effective management requires integrating AI adoption with workforce development strategies, including training, upskilling, and inclusive change management practices. Neglecting these aspects can impede AI-driven innovation and hinder overall productivity.

5. Temporal Limitations: The rapid evolution of AI technologies means that research findings can quickly become outdated. Emerging algorithms, tools, and platforms continuously redefine best practices, making longitudinal studies crucial for understanding sustained economic impacts. Without ongoing evaluation, theoretical models risk reflecting only transient conditions rather than the dynamic reality of technological change.

6. Policy and Regulatory Constraints: Legal and regulatory environments significantly shape how managers deploy AI. Many jurisdictions are still developing frameworks for data ownership, cross-border data transfer, digital competition, and ethical AI use. Regulatory uncertainty can discourage investment in AI, promote risk-averse managerial behavior, and slow innovation. Inconsistent policies across countries further complicate multinational corporations' ability to implement coherent AI strategies globally.

In conclusion, while AI has emerged as a transformative force capable of stimulating economic growth, its full potential depends on the alignment of managerial competence, supportive organizational environments, robust technical infrastructure, and clear regulatory frameworks. Recognizing and addressing these limitations is critical to harnessing AI effectively for sustainable economic development.

Conclusion

Managerial competence and innovations driven by artificial intelligence (AI) emerge as pivotal catalysts for achieving sustainable economic growth. Managerial competence, characterized by strategic foresight, adaptive leadership, and sound decision-making, provides the human guidance necessary for navigating the complexities and uncertainties of the modern digital economy. At the same time, AI-enabled technologies including machine learning, advanced data analytics, and the Internet of Things (IoT) have fundamentally transformed organizational environments by enabling predictive insights, optimizing operational processes, and creating new avenues for value generation.

The interaction between managerial competence and AI demonstrates a mutually reinforcing dynamic. Skilled managers facilitate the effective adoption and integration of AI technologies, ensuring that these tools are aligned with organizational objectives and societal goals. Conversely, AI systems enhance managerial capabilities by providing actionable, data-driven insights at scale, allowing leaders to make informed decisions more efficiently and accurately. Organizations that develop both high-caliber managerial talent and sophisticated technological infrastructure are therefore better equipped to anticipate market shifts, optimize resource utilization, and strengthen operational performance, ultimately contributing to long-term economic resilience and growth.

This analysis underscores that sustainable economic development is not solely the product of technological adoption; rather, it is the outcome of human leadership that strategically harnesses these innovations in a responsible, ethical, and forward-looking manner. The alignment of managerial expertise with emerging AI technologies establishes a foundation for organizational and societal adaptability, inclusiveness, and competitiveness in an increasingly interconnected, data-driven world. As economies continue to evolve, the ability to synergize managerial insight with technological sophistication will remain a decisive factor in shaping both organizational success and broader economic advancement.

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