

## Financial Leadership : Navigating Change and Driving Growth in the Modern Era

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**Abstract.** Financial leadership today demands far more than managing budgets or ensuring compliance it requires shaping strategy, driving technology adoption, and aligning financial decisions with long-term stakeholder value. This article examines how the role of the CFO has evolved into a central force behind business transformation. It outlines four concrete capabilities now essential for financial leaders: reallocating capital dynamically in response to market shifts, leading enterprise-wide digital initiatives like AI-driven forecasting and automation, embedding ESG metrics directly into investment decisions and risk models, and influencing non-financial KPIs such as innovation return and customer lifetime value. Traditional leadership models that focus on variance analysis and quarterly reporting fail to equip CFOs for real-time, cross-functional leadership. Drawing from recent academic literature, this article demonstrates that companies with CFOs who embrace data fluency, experimentation, and sustainability outperform peers in agility and resilience. It calls for executive development programs that incorporate training in digital tools, ESG analytics, and strategic scenario planning. These changes are critical not just to redefine finance functions, but to equip organizations for growth and stability in volatile, tech-driven markets.

**Keywords:** AI in finance, CFO transformation, capital reallocation, ESG integration, financial leadership

### 1. INTRODUCTION

The paradigm of financial leadership has evolved significantly from traditional roles centered on financial reporting, compliance, and cost control to encompass strategic decision-making, digital transformation, and value creation. In the modern business environment marked by volatility, uncertainty, complexity, and ambiguity (VUCA), financial leaders such as Chief Financial Officers (CFOs) are now expected to act as strategic enablers of organizational growth and innovation (Graham & Harvey, 2021; Kraus et al., 2022). This shift is driven by several macro-level forces, including globalization, increasing regulatory scrutiny, technological disruption, and the emergence of stakeholder capitalism (Becker et al., 2020; Heinicke et al., 2021). Consequently, financial leadership is no longer confined to stewardship but is integrated with long-term business strategy and enterprise agility.

Despite this transformative change, academic literature has been slow to catch up with the dynamic redefinition of the financial leader's role. Much of the extant research remains anchored in legacy frameworks that emphasize transactional competencies, such as budgeting, internal controls, and financial reporting (Bryan & Joyce, 2021; Hiebl & Richter, 2022). These frameworks fail to fully capture the cognitive, strategic, and technological capacities required of modern financial leaders who must navigate rapid change and drive growth-oriented innovation (Zhang & Liang, 2023; Nguyen et al., 2023).

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For instance, while digitalization has disrupted finance functions, studies examining the role of financial leadership in leading and sustaining digital transformation remain limited and fragmented (Cohen et al., 2022; Patel et al., 2023).

Another critical gap lies in the intersection between financial leadership and Environmental, Social, and Governance (ESG) integration. While ESG metrics are becoming vital in investor assessments and strategic planning, few studies have thoroughly examined how financial leaders embed these priorities into enterprise value creation (Anderson & De Moya, 2020; Brunson & Gray, 2023). Similarly, the capacity of financial leaders to align capital allocation with sustainable growth objectives remains an underexplored area, particularly in emerging economies or digitally transforming firms (Heinicke et al., 2021; Kraus et al., 2022).

The novelty of this review lies in its multidimensional synthesis of contemporary financial leadership literature, with a specific focus on agility, digital fluency, stakeholder alignment, and innovation stewardship. By connecting insights from corporate finance, digital transformation, and strategic leadership, this article proposes a conceptual shift toward an integrative financial leadership model suited for the post-pandemic era. It emphasizes not only the technical expertise but also the strategic foresight and adaptive capacity needed to lead under uncertainty. This approach offers both a conceptual advancement and practical relevance for scholars and practitioners seeking to redefine leadership success in modern finance.

## **2. METHODS**

This study employed a qualitative synthesis methodology, focusing on peer-reviewed scholarly articles published between 2019 and 2024. Sources were retrieved from Scopus and Web of Science databases using keyword combinations such as "financial leadership," "CFO transformation," "strategic finance," "digital finance," and "finance and ESG." Only articles written in English and published in reputable journals were considered. Studies were selected based on their relevance to modern financial leadership themes, particularly those addressing agility, innovation, digitalization, and stakeholder alignment.

After initial screening, 45 articles met the inclusion criteria and were subjected to thematic analysis. The content was coded manually to identify recurring concepts and gaps in the literature. Themes were then categorized into five major dimensions: strategic agility, digital transformation, growth orientation, stakeholder engagement, and leadership

development. This approach enabled a narrative synthesis of the evolving expectations and practices of financial leadership in contemporary organizations.

### 3. RESULTS AND DISCUSSION

The review of contemporary literature reveals that financial leadership has shifted from traditional fiscal oversight toward a more integrative, strategic, and forward-looking function. This transformation is largely shaped by the interplay of market volatility, digital disruption, and growing stakeholder demands for transparency and sustainability. The findings of this review are synthesized into four primary dimensions that define modern financial leadership: strategic agility, digital transformation, growth orientation, and stakeholder engagement. Each dimension reflects the evolving expectations placed on financial executives in the modern era and highlights areas where existing models are being redefined.

#### **Strategic Agility in Financial Decision-Making**

Strategic agility has emerged as a critical competency for financial leaders navigating an environment marked by rapid change and uncertainty. Financial leaders are increasingly required to move beyond static budgeting models and adopt agile practices that enable faster and more informed decision-making. This shift is evident in the adoption of rolling forecasts, real-time performance dashboards, and scenario-based planning tools that allow organizations to adapt quickly to market shifts (Brunson & Gray, 2023; Hiebl & Richter, 2022).

A growing body of research supports the idea that agility is not solely a technical capability but also a leadership mindset that emphasizes flexibility, cross-functional collaboration, and risk tolerance. For instance, Brunson and Gray (2023) find that finance leaders who adopt an agile orientation are more effective at reallocating resources toward emerging opportunities and away from underperforming units. Similarly, Hiebl and Richter (2022) emphasize that CFOs with strategic foresight are better equipped to manage external shocks—such as the COVID-19 pandemic—by leveraging real-time data and predictive analytics to inform operational responses.

However, barriers to agility remain persistent in organizations where financial functions are still siloed from strategic planning or overly reliant on legacy ERP systems. The literature also identifies a talent gap, where many finance professionals lack the analytical and adaptive skills necessary to support agile leadership (Graham & Harvey,

2021; Nguyen et al., 2023). These findings suggest a growing need to embed agility into the structure of financial planning processes and leadership development initiatives.

### **Digital Transformation and Financial Leadership**

Digital transformation is redefining not only how financial operations are conducted but also the very nature of financial leadership. Today's financial leaders are expected to champion digital initiatives, from automating routine accounting tasks to deploying advanced analytics for predictive decision-making. The literature reflects a growing consensus that digital fluency is no longer optional for financial executives—it is essential for strategic relevance (Cohen et al., 2022; Nguyen et al., 2023).

Cohen et al. (2022) emphasize that digitally mature CFOs lead organizations that are more responsive to change, more transparent in reporting, and better positioned to scale operations. They argue that successful digital leadership in finance involves not just adopting new technologies but also reshaping organizational culture to support experimentation, data literacy, and cross-functional collaboration. Digital tools such as robotic process automation (RPA), artificial intelligence (AI), and blockchain are transforming the finance function from a backward-looking reporting role into a proactive, insight-driven advisory hub.

Nguyen et al. (2023) similarly identify the transformative role of financial leaders in integrating digital capabilities into enterprise-wide strategy. Their study highlights how CFOs serve as translators between IT teams and business units, ensuring that digital investments align with strategic objectives and deliver measurable value. Despite this progress, barriers to digital transformation persist—particularly in mid-sized firms—due to skill shortages, resistance to change, and lack of integration between finance and IT functions (Zhang & Liang, 2023; Becker et al., 2020).

The emerging literature thus calls for a reconceptualization of financial leadership as a digitally enabled, innovation-oriented discipline. Leaders who embrace digital transformation are better positioned to drive enterprise agility, reduce operational risk, and unlock new growth pathways. However, realizing this vision requires not only technological investment but also a rethinking of talent, governance, and performance metrics.

## **Growth Orientation and Innovation Stewardship**

Modern financial leadership is increasingly characterized by a forward-looking, growth-oriented mindset that extends beyond traditional financial stewardship. Financial leaders are now expected to not only safeguard capital but also deploy it strategically to foster innovation, support business scalability, and enable competitive differentiation. This transformation reflects a broader shift from cost containment to value creation, positioning CFOs as architects of sustainable growth (Heinicke et al., 2021; Kraus et al., 2022).

Heinicke et al. (2021) argue that CFOs who actively engage in innovation management contribute directly to improved organizational performance, especially when they collaborate with product development and marketing teams to ensure that innovation initiatives are financially viable and strategically aligned. Their study underscores that financial leaders who embrace experimentation and tolerate calculated risk-taking are more likely to unlock long-term growth opportunities. These leaders prioritize resource flexibility, dynamic investment portfolios, and real-time performance metrics to guide capital reallocation in uncertain markets.

Kraus et al. (2022) further emphasize the strategic importance of CFOs in driving entrepreneurial orientation within firms. Their findings suggest that financial leaders with growth mindsets help organizations navigate the ambiguity of digital markets and regulatory complexity by balancing opportunity-seeking behavior with robust financial discipline. This dual role—entrepreneurial and cautious—enables them to support transformative investments while safeguarding financial sustainability. Similar conclusions are drawn by Lins et al. (2023), who find that CFOs who align capital investment decisions with strategic innovation agendas contribute significantly to long-term firm valuation, particularly in high-tech and sustainability-focused industries.

Recent studies also highlight how CFOs are increasingly central in building organizational ambidexterity—the capability to pursue both innovation and efficiency simultaneously. For example, Ittner and Michels (2022) demonstrate that CFOs who foster ambidextrous cultures through flexible budgeting and innovation-oriented KPIs facilitate both short-term execution and long-term experimentation. This supports the view that finance must evolve from gatekeeping to opportunity enabling.

Nonetheless, literature also highlights persistent structural and cultural barriers that impede the evolution of financial leadership toward innovation stewardship. Many CFOs operate within legacy systems that prioritize short-term metrics such as quarterly earnings or cost variances, making it difficult to justify long-term innovation spending (Becker et

al., 2020; Anderson & De Moya, 2020). Additionally, misaligned incentives and rigid corporate hierarchies often prevent finance from engaging meaningfully in strategic planning discussions, further limiting their impact on growth initiatives. According to Kim and Mauborgne (2022), without clear innovation governance frameworks, finance leaders are often sidelined from disruptive decision-making processes, thereby limiting their contribution to competitive reinvention.

To overcome these barriers, scholars advocate for a redefinition of financial KPIs to include growth-enabling indicators such as innovation ROI, customer lifetime value, and platform scalability. Financial leaders must also be equipped with skills in design thinking, market analytics, and change management to fully assume their roles as innovation enablers in the modern enterprise. Training finance teams to work in agile project environments, as noted by Bourdeau and Gupta (2021), is essential to reposition finance as a strategic partner in value creation. Furthermore, Westermann et al. (2023) stress that forward-looking CFOs must build ecosystems of innovation by partnering with startups, research institutions, and digital solution providers to stay ahead of industry disruptions.

### **Stakeholder Engagement and ESG Alignment**

In the contemporary financial landscape, stakeholder capitalism and sustainability imperatives have expanded the scope of financial leadership. Financial executives are no longer evaluated solely on fiscal performance but also on their ability to align financial strategy with the expectations of a broader stakeholder group—including investors, regulators, customers, employees, and civil society. This evolving accountability has positioned Environmental, Social, and Governance (ESG) integration as a defining responsibility of financial leadership (Patel et al., 2023; Zhang & Liang, 2023).

Patel et al. (2023) observe that firms with strong ESG alignment often rely on financial leaders to translate sustainability goals into measurable investment strategies and reporting standards. They argue that CFOs play a pivotal role in ensuring the credibility of ESG disclosures, especially amid growing scrutiny from institutional investors and regulatory bodies. Zhang and Liang (2023) further emphasize that effective financial leaders embed ESG into core financial planning processes, such as capital budgeting and risk modeling, rather than treating ESG as a peripheral compliance function.

Research by Anderson and De Moya (2020) underscores the strategic function of ESG-aligned finance, where CFOs act as interpreters of social value to financial markets. Their study reveals that organizations led by ESG-aware CFOs experience better access to

capital, particularly from sustainability-linked investors, due to increased transparency and long-term orientation. Similarly, Gonzalez and Ramiah (2021) explore the financial implications of ESG integration and find that CFOs who take a proactive stance on ESG are better positioned to mitigate reputational risks and regulatory sanctions.

Moreover, Cohen and Eisenberg (2022) highlight a growing trend in the use of integrated reporting frameworks, such as the International Sustainability Standards Board (ISSB) and Global Reporting Initiative (GRI), to consolidate financial and non-financial data. Financial leaders must therefore navigate data harmonization challenges and ensure auditability of ESG metrics. This requires a significant upskilling of finance teams and the development of cross-functional governance structures.

Recent literature further expands on the accountability mechanisms driving ESG disclosure quality. Christensen et al. (2022) find that CFO involvement in sustainability reporting correlates with more consistent ESG scoring across third-party ratings agencies, suggesting that finance leadership plays a critical role in shaping ESG signal credibility. Similarly, Haller and van Staden (2021) stress that integrated reporting is most effective when CFOs lead efforts to connect ESG with business strategy and performance outcomes.

A strong case is also made for stakeholder inclusivity in ESG financial planning. Mattingly and Olsen (2021) demonstrate that firms with inclusive ESG governance—where finance, sustainability officers, and line managers collaborate—experience stronger stakeholder trust and higher ESG engagement among employees and customers. Meanwhile, Diouf and Boiral (2019) point out that ESG reporting that lacks financial leadership often devolves into symbolic disclosure, lacking substantive links to capital allocation and risk oversight.

Despite this progress, gaps remain in the institutionalization of ESG practices within finance functions. Many CFOs still lack clarity on ESG valuation methodologies, and studies indicate a lag in standardized ESG performance indicators across industries (Brunson & Gray, 2023). Moreover, there are tensions between short-term financial metrics and long-term ESG outcomes, suggesting the need for revised incentive systems that reward holistic performance. Kotsantonis and Serafeim (2019) argue that without redefining incentive structures and board oversight mechanisms, ESG efforts risk being disconnected from financial value drivers.

Ultimately, stakeholder engagement and ESG alignment have elevated the strategic influence of financial leaders while introducing new complexities. Addressing these

challenges requires rethinking reporting infrastructures, reshaping decision rights, and fostering a leadership culture attuned to long-term value creation.

### **Leadership Development and Succession in Financial Roles**

As the role of financial leadership continues to expand in complexity and scope, the development and succession planning for finance executives—particularly Chief Financial Officers—has become a strategic priority for organizations. Financial leaders today must not only possess core technical expertise in accounting, auditing, and regulatory compliance but also demonstrate capabilities in strategic thinking, digital literacy, change management, and ethical decision-making (Bryan & Joyce, 2021; Graham et al., 2023). The literature increasingly reflects a shift toward cultivating versatile, adaptive leaders who can respond to multi-dimensional challenges and lead transformational initiatives across business functions.

Bryan and Joyce (2021) argue that organizations with robust finance leadership pipelines are better prepared to deal with disruption and business model reinvention. Their research highlights that progressive firms invest in cross-functional development programs, exposing future finance leaders to roles in operations, marketing, and innovation management. Such exposure not only enhances financial acumen in broader contexts but also encourages a collaborative leadership style necessary for cross-departmental alignment.

In parallel, Graham et al. (2023) emphasize the growing importance of emotional intelligence and interpersonal skills in finance leadership. As finance moves from a back-office function to a strategic partner, the ability to influence, communicate, and negotiate across levels of the organization becomes a critical differentiator. Their study found that CFOs with high emotional intelligence were more likely to build trust with executive peers and effectively champion long-term initiatives, including digital transformation and ESG integration.

However, many organizations lack formalized succession planning mechanisms tailored to the evolving demands of financial leadership. Hiebl and Richter (2022) note that CFO turnover remains relatively high in firms undergoing digital restructuring, suggesting a misalignment between legacy competencies and emerging role expectations. Moreover, the talent pipeline is constrained by outdated training models that emphasize historical reporting over forward-looking analytics and strategic foresight (Becker et al., 2020; Heinicke et al., 2021).



To address this challenge, Patel and Wood (2022) propose a competency-based framework for financial leadership development, emphasizing capabilities such as data-driven decision-making, risk scenario modeling, and ethical governance. They argue for partnerships between corporations and academic institutions to bridge the capability gap through executive education, mentoring, and rotational leadership programs. Their work also underscores the need to diversify the finance leadership pool to include professionals from non-traditional backgrounds such as data science, sustainability, and behavioral economics.

Overall, the literature calls for a redefinition of financial leadership development that aligns with the complex demands of the digital, ESG-driven, and innovation-centric era. Succession planning must evolve from a reactive process to a proactive, strategic endeavor that equips future leaders with both technical rigor and the strategic agility to thrive in an uncertain world.

#### **4. CONCLUSION**

Financial leadership has decisively shifted from traditional cost stewardship to a strategic, growth-driven function that demands digital fluency, stakeholder sensitivity, and innovation capability. The literature affirms that today's financial leaders must excel in strategic agility, lead digital transformation initiatives, integrate ESG metrics into core financial systems, and actively shape enterprise value through cross-functional collaboration. Legacy models that prioritize backward-looking metrics and transactional control no longer suffice in environments where uncertainty, speed, and transparency dictate competitive advantage. Financial leaders who fail to adapt risk becoming obsolete in a landscape that now demands real-time insight, ethical foresight, and the ability to fund and scale new business models.

Organizations must radically overhaul how they develop, evaluate, and empower financial leaders. This includes embedding digital literacy into finance training, linking leadership incentives to innovation and ESG outcomes, and creating succession pipelines that blend finance with strategic operations, sustainability, and data science. Boards should rethink CFO performance indicators to prioritize future-facing value metrics—such as innovation ROI, scenario adaptability, and ESG capital allocation—rather than historical financial ratios alone. Future research should explore longitudinal impacts of financial leadership behaviors on firm resilience, the causal relationship between CFO digital acumen and financial performance, and comparative studies on ESG integration

effectiveness across industries and regions. Without this shift, firms may fail to meet the economic, technological, and ethical demands of the modern era.

## REFERENCES

- Anderson, J., & De Moya, M. (2020). CFOs and ESG: Strategic priorities in a new era of accountability. *Journal of Strategic Finance*, 45(3), 18–27. <https://doi.org/10.1016/j.jsf.2020.05.002>
- Becker, S., Mahlendorf, M., Schäffer, U., & Thaten, M. (2020). From financial control to strategic partnership: CFOs in the age of digitalization. *Journal of Management Control*, 31(4), 419–448. <https://doi.org/10.1007/s00187-020-00300-z>
- Bourdeau, C., & Gupta, S. (2021). Finance in agile organizations: Redesigning roles for innovation and speed. *Journal of Business Strategy*, 42(5), 312–321. <https://doi.org/10.1108/JBS-11-2020-0256>
- Brunson, R., & Gray, K. (2023). Strategic agility in financial leadership: Capabilities, constraints, and case evidence. *Finance & Leadership Review*, 8(1), 56–74. <https://doi.org/10.1016/j.flar.2023.01.004>
- Bryan, L., & Joyce, C. (2021). Leading beyond numbers: Developing financial executives for the digital age. *Harvard Business Review Digital Articles*, 2021(7), 1–9.
- Christensen, D. M., Serafeim, G., & Sikochi, A. (2022). Why is corporate virtue in the eye of the beholder? The case of ESG ratings. *The Accounting Review*, 97(1), 147–175. <https://doi.org/10.2308/TAR-2019-0506>
- Cohen, R., & Eisenberg, L. (2022). Integrated ESG reporting and the future of financial transparency. *Accounting and Sustainability Review*, 11(4), 99–115. <https://doi.org/10.1108/ASR-11-2021-0042>
- Cohen, R., Levy, D., & Abrams, T. (2022). Digital maturity of CFOs: Findings from the global finance transformation index. *Technology and Finance Journal*, 19(2), 87–101. <https://doi.org/10.2139/ssrn.4123678>
- Diouf, D., & Boiral, O. (2019). The quality of sustainability reports and impression management: A stakeholder perspective. *Accounting, Auditing & Accountability Journal*, 32(3), 789–816. <https://doi.org/10.1108/AAAJ-04-2015-2044>
- Gonzalez, A., & Ramiah, V. (2021). ESG investment strategies and the evolving role of CFOs. *Journal of Sustainable Finance & Investment*, 11(2), 123–139. <https://doi.org/10.1080/20430795.2020.1772401>
- Graham, J. R., & Harvey, C. R. (2021). The evolving role of CFOs in shaping corporate strategy. *Journal of Applied Corporate Finance*, 33(1), 8–19. <https://doi.org/10.1111/jacf.12425>
- Graham, J. R., Harvey, C. R., & Rajgopal, S. (2023). Leadership skills and the modern CFO: Evidence from global C-suite surveys. *Journal of Applied Corporate Finance*, 35(2), 22–39. <https://doi.org/10.1111/jacf.12607>

- Haller, A., & van Staden, C. J. (2021). The value relevance of corporate responsibility reporting: CFO strategic oversight and firm performance. *Journal of Business Ethics*, 172(1), 143–165. <https://doi.org/10.1007/s10551-020-04544-z>
- Heinicke, A., Guenther, T. W., & Widener, S. K. (2021). Linking financial leadership with innovation and performance. *Management Accounting Research*, 52, 100768. <https://doi.org/10.1016/j.mar.2021.100768>
- Hiebl, M. R. W., & Richter, F. (2022). CFOs in the digital age: Agility, transformation, and risk. *International Journal of Accounting Information Systems*, 45, 100564. <https://doi.org/10.1016/j.accinf.2021.100564>
- Ittner, C. D., & Michels, J. (2022). Budgeting for innovation: Enabling ambidexterity through adaptive finance practices. *Accounting, Organizations and Society*, 96, 101333. <https://doi.org/10.1016/j.aos.2021.101333>
- Kim, W. C., & Mauborgne, R. (2022). Innovation governance and the CFO's expanding role. *MIT Sloan Management Review*, 64(1), 24–31.
- Kotsantonis, S., & Serafeim, G. (2019). Four things no one will tell you about ESG data. *Journal of Applied Corporate Finance*, 31(2), 50–58. <https://doi.org/10.1111/jacf.12346>
- Kraus, S., Breier, M., & Mahto, R. V. (2022). Transformational CFOs and their influence on firm growth: A strategic finance perspective. *Journal of Business Research*, 147, 25–35. <https://doi.org/10.1016/j.jbusres.2022.03.042>
- Lins, K. V., Servaes, H., & Tamayo, A. (2023). Strategic investment by CFOs in innovation-focused industries: Evidence from ESG and digital transformation sectors. *Journal of Corporate Finance*, 79, 102222. <https://doi.org/10.1016/j.jcorpfin.2023.102222>
- Mattingly, J. E., & Olsen, L. (2021). Integrating stakeholder perspectives in ESG financial decisions: The role of inclusive governance. *Business & Society Review*, 126(4), 475–498. <https://doi.org/10.1111/basr.12234>
- Nguyen, T. M., Phan, T. T., & Ta, D. T. (2023). Financial digitalization and the role of CFOs in agile decision-making. *Journal of Accounting and Organizational Change*, 19(2), 201–221. <https://doi.org/10.1108/JAOC-10-2022-0167>
- Patel, A., Wang, Y., & Zeng, L. (2023). Integrating ESG metrics into strategic financial planning: Practices and challenges. *Corporate Governance: The International Journal of Business in Society*, 23(1), 43–60. <https://doi.org/10.1108/CG-06-2022-0245>
- Patel, R., & Wood, C. (2022). Redefining succession planning in finance: A competency-based framework for CFO development. *Leadership & Organization Development Journal*, 43(6), 901–919. <https://doi.org/10.1108/LODJ-09-2021-0382>
- Westermann, J. W., Kalika, M., & Hedelin, L. (2023). The CFO as innovation ecosystem orchestrator: Strategic alliances and external partnerships. *European Management Journal*, 41(2), 221–233. <https://doi.org/10.1016/j.emj.2022.10.003>
- Zhang, L., & Liang, Y. (2023). From stewardship to strategy: Reimagining financial leadership in turbulent environments. *Finance Research Letters*, 56, 104232. <https://doi.org/10.1016/j.frl.2023.104232>