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A Review of Technology Management Practices

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Abstract

Technology management encompasses the set of processes, practices, and governance arrangements that enable organizations to acquire, develop, adopt, deploy, and retire technology in ways that create and sustain competitive advantage. As digitalization, platformization, and rapid innovation reshape markets, organizations must combine technical competence with managerial practices—R&D management, technology strategy, IT governance, open innovation, technology transfer, lifecycle and portfolio management, standards and interoperability, intellectual property (IP) management, cybersecurity, and sustainability-driven technology practices—to succeed. This review synthesizes theoretical foundations and empirical evidence on core technology management practices, compares strengths and limits, and highlights integrative approaches (e.g., ambidexterity, dynamic capabilities, and ERM-style technology governance) that improve outcomes. The paper concludes with practical guidance and future research priorities including AI-enabled technology governance, socio-technical resilience, and sustainability-aligned technology portfolios.

Introduction

Technology has become the central axis of value creation and competitive rivalry across virtually every industry. The capacity to conceive, deploy, and orchestrate technological resources—both digital and physical—determines organizational agility, innovation performance, and long-term resilience. For managers, "technology" is not merely a collection of tools or capabilities but an area of practice that requires systematic governance, strategic alignment, and continuous learning. Technology management practices therefore span strategy, organization, processes, people, and external relationships.

Early literature on technological change and industrial dynamics emphasized the organizational and sectoral patterns through which innovation occurs. Classic work by Abernathy and Utterback (1978) identified patterns of product and process innovation over industry lifecycles, illustrating that managerial practices must change as technologies mature. Nelson and Winter (1982) developed an evolutionary theory that highlighted routines and capabilities as the unit of technological persistence and change. Building on these foundations, scholars emphasized knowledge creation and transfer (Nonaka & Takeuchi, 1995), architectures of innovation (Henderson & Clark, 1990), and the diffusion of innovations (Rogers, 2003).

In contemporary practice, the challenges for technology managers are manifold. First, the pace of change has accelerated: digital technologies and software-driven innovation shorten development cycles and create platform-based competition (Gawer & Cusumano, 2002). Second, the sources of innovation have expanded beyond internal R&D; firms increasingly tap external partners, user communities, and open innovation networks (Chesbrough, 2003; Vanhaverbeke et al., 2008). Third, the governance

of technology—especially IT and data—poses new regulatory, ethical, and security demands (Weill & Ross, 2004; Sambamurthy, Bharadwaj, & Grover, 2003).

These developments require that managers adopt integrated technology management practices. Traditional R&D management and stage-gate development processes (Cooper, 1990) remain important for major engineering projects. At the same time, agile product development and modular architectures allow faster iterations (Eisenhardt & Tabrizi, 1995). Open innovation practices can accelerate learning and reduce cost, but they require absorptive capacity to capture and recombine external knowledge (Zahra & George, 2002; Kogut & Zander, 1992). Technology portfolio management and roadmapping help align investment with strategic priorities and lifecycle stage (Tidd & Bessant, 2018).

Managing technology also requires careful attention to governance. IT governance frameworks (Weill & Ross, 2004) and enterprise technology governance (Sambamurthy et al., 2003) allocate decision rights, set investment criteria, and balance centralization with local autonomy. Governance must be complemented by practices such as IP protection, standards participation, and cybersecurity defenses. Platform leaders must also manage ecosystems: platform architecture, developer relations, and governance of third-party contributions (Gawer & Cusumano, 2002; Shapiro & Varian, 1999).

Another central theme in the literature is ambidexterity and dynamic capabilities. Organizations need to exploit current technologies while exploring emerging ones (Tushman & O'Reilly, 1996; Teece, Pisano, & Shuen, 1997). Practically, this means creating structures and processes that support both stable delivery (e.g., operations, maintenance, compliance) and exploratory innovation (incubators, skunkworks, corporate venture units). Without ambidexterity, firms risk competence traps or excessive risk-taking.

Technology management practices must also incorporate social and sustainability dimensions. The growing emphasis on responsible innovation and the environmental impacts of technology requires integrating sustainability criteria into technology selection, design, and retirement decisions (Pisano, 2015; Baines et al., 2009). Meanwhile, digital ethics and data governance are essential for legitimacy and regulatory compliance.

Despite rich prescriptions, research finds that organizations often struggle to operationalize technology management. Common weaknesses include poor coordination between R&D and business units, failure to update governance as digital initiatives scale, weak absorptive capacity for external innovation, and inadequate risk management for complex socio-technical systems (Dodgson, Gann, & Salter, 2008; Lam, 2014). To address these gaps, the field recommends integrated practices combining strategic roadmapping, platform thinking, ambidextrous organization design, rigorous IP and data governance, and continuous capabilities development.

This review synthesizes the literature on core technology management practices, comparing strengths and weaknesses, and proposing integrative pathways. The next section catalogues the major scholarly contributions that inform practice. Following that, the paper presents a comparative table of technology management practices, an analysis, and a focused discussion that distils managerial implications and research directions.

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Core technology management practices

1. **Technology strategy and roadmapping** — aligning technology investments with business strategy and creating multi-year roadmaps for capability development (Tidd & Bessant, 2018; Pisano, 2015).
2. **R&D and product development management** — portfolio selection, stage-gate and agile hybrid processes for new product development (Cooper, 1990; Eisenhardt & Tabrizi, 1995).
3. **IT governance and digital governance** — assigning decision rights and accountability for IT/digital investments (Weill & Ross, 2004; Sambamurthy et al., 2003).
4. **Open innovation and external sourcing** — inbound/outbound knowledge flows, alliances, and crowdsourcing (Chesbrough, 2003; von Hippel, 2005).
5. **Technology acquisition & transfer** — M&A, licensing, standards participation and technology scouting (Dodgson et al., 2008; Shapiro & Varian, 1999).
6. **Platform and ecosystem management** — platform architecture, governance of complementors and multi-sided markets (Gawer & Cusumano, 2002; Shapiro & Varian, 1999).
7. **Absorptive capacity & knowledge integration** — building routines to recognize, assimilate, and apply external knowledge (Zahra & George, 2002; Kogut & Zander, 1992).
8. **Technology lifecycle & portfolio management** — balancing exploitative vs exploratory investments across lifecycle stages (Abernathy & Utterback, 1978; Tushman & O'Reilly, 1996).
9. **Standards, interoperability, and IP management** — participation in standards bodies and IP strategy (Shapiro & Varian, 1999; Prahalad & Hamel, 1990).
10. **Cybersecurity & resilience practices** — hardening, incident response, and continuity planning as part of technology governance (Weill & Ross, 2004).
11. **Data governance and analytics capability** — data quality, stewardship, analytics platform management (Sambamurthy et al., 2003; Tidd & Bessant, 2018).
12. **Sustainability and servitization** — incorporating environmental and service offerings into technology strategy (Baines et al., 2009; Pisano, 2015).

Comparative table and analysis

1. Comparative table of selected technology management practices

Practice	Primary objective	Typical tools/processes	Strengths	Key limitations
Technology strategy & roadmapping	Align tech investments to strategy	Roadmaps, scenario planning, portfolio matrices	Long-term coherence; prioritization	Forecast uncertainty; political bias

R&D & product development mgmt	Create new products/services	Stage-gate, agile sprints, prototyping	Structured progress; rapid learning	Siloing; stage-gate rigidity
IT / digital governance	Optimize IT value & risk	Decision rights, COBIT-like controls	Accountability; cost control	Over-centralization; stifles innovation
Open innovation	Access external ideas	Alliances, crowdsourcing, licensing	Faster learning; cost sharing	IP risk; integration difficulty
Platform/ecosystem mgmt	Orchestrate multi-sided value	APIs, SDKs, partner programs	Network effects; scalability	Governance complexity; winner-take-all dynamics
Absorptive capacity	Learn from external sources	Training, boundary spanners	Knowledge recombination	Capability build time; costs
Technology portfolio mgmt	Balance risk & reward	Portfolio analysis; stage investment	Resource allocation; diversification	Mis-measurement; path dependency
Standards & IP mgmt	Protect & scale tech	Patents, standards bodies	Market lock-in; interoperability	Patent thickets; slowed innovation
Cybersecurity & resilience	Protect assets & continuity	Incident response, backups, DR	Risk reduction; trust	Resource heavy; unknown threats
Data governance & analytics	Turn data into value	Data catalogs, governance boards	Better decisions; compliance	Data silos; privacy concerns
Sustainability & servitization	Long-term viability & value	LCA, servitization pilots	Differentiation; recurring revenue	Capex intensity; organizational change

2. Comparative analysis

The table shows that practices vary by orientation (exploitative vs exploratory), time horizon (short operational vs long strategic), and governance complexity. Practices such as open innovation and platform management enable accelerated growth but require strong absorptive capacity and governance to avoid IP leakage or ecosystem failure (Chesbrough, 2003; Gawer & Cusumano, 2002). R&D and stage-gate frameworks provide structure for development but are complemented by agile methods for speed in uncertain contexts (Cooper, 1990; Eisenhardt & Tabrizi, 1995). IT/digital governance balances central control with local innovation (Weill & Ross, 2004; Sambamurthy et al., 2003). Sustainability and servitization push managers to integrate technology decisions with environmental and service strategy, demanding cross-functional coordination (Baines et al., 2009; Pisano, 2015).

Across practices, absorptive capacity and dynamic capabilities emerge as cross-cutting enablers: firms that can reconfigure resources and integrate external knowledge achieve superior outcomes (Teece et al., 1997; Zahra & George, 2002). Similarly, platform and ecosystem strategies amplify returns to scale but intensify governance demands.

Discussion

This review synthesizes the core practices of technology management and underscores several cross-cutting themes relevant to both scholars and practitioners.

Integration and alignment. Multiple literatures emphasize that technology practices cannot be implemented in isolation. Roadmapping, portfolio management, IT governance, and R&D processes must be aligned to corporate strategy to avoid wasted investment and conflicting priorities (Tidd & Bessant, 2018; Pisano, 2015). Strategic misalignment frequently leads to orphaned projects and capability gaps.

Ambidexterity and capability balance. Firms must both exploit existing technologies and explore disruptive opportunities. Successful organizations create structures and processes supporting ambidexterity—e.g., separate units or time-sliced investment—while ensuring

knowledge transfer across units (Tushman & O'Reilly, 1996; Teece et al., 1997). This balance is particularly important in industries undergoing architectural change (Henderson & Clark, 1990; Christensen, 1997).

Openness vs control tradeoffs. Open innovation, M&A, and alliances accelerate technology access but raise integration, IP, and coordination challenges (Chesbrough, 2003; Dodgson et al., 2008). Managers must build absorptive capacity, clear contracting, and integration processes to capture external value (Zahra & George, 2002).

Platform dynamics and ecosystem governance. Platform strategies reshape competitive dynamics; platform leaders gain increasing returns but also face delicate governance choices that influence partner behavior and innovation incentives (Gawer & Cusumano, 2002; Shapiro & Varian, 1999). Technology managers must design architectural modularity and partner incentives carefully.

Data & digital governance as a core practice. As data becomes an essential asset, governance around data quality, stewardship, analytics, and ethical use is central to deriving value and maintaining trust (Sambamurthy et al., 2003). Cybersecurity and resilience are now part of core technology management rather than an IT afterthought (Weill & Ross, 2004).

Sustainability and servitization. Technology strategy increasingly incorporates environmental and service components. Managers must evaluate lifecycle impacts and develop offerings emphasizing outcomes rather than products—requiring integration between engineering, service delivery, and finance (Baines et al., 2009; Pisano, 2015).

Organizational routines and learning. Deep, persistent capabilities—such as routines for knowledge recombination and technology scouting—matter more than ad hoc projects (Nelson & Winter, 1982; Nonaka & Takeuchi, 1995). Investments in people, processes, and boundary spanners pay off over time.

Implementation challenges. Many firms struggle with coordination, legacy systems, misaligned KPIs, and short-term bias. Practical remedies include executive sponsorship, cross-functional governance boards, capability roadmaps, and experimentation spaces (Cooper, 1990; Tidd & Bessant, 2018).

Conclusion

Technology management practices are a vital managerial repertoire for firms seeking to create, capture, and sustain value in an increasingly technology-driven world. This review has mapped the primary practices—from strategic roadmapping and R&D management to open innovation, platform governance, and data stewardship—and synthesized evidence on their strengths, limitations, and interdependencies.

A few broad conclusions emerge. First, **no single practice suffices**: organizations need an integrated portfolio of practices tailored to their strategy, industry dynamics, and maturity. For instance, a firm competing on short-cycle software innovation will emphasize agile development, platform orchestration, and analytics, whereas an engineering-intensive manufacturer will emphasize R&D governance, lifecycle management, IP protection, and servitization pathways (Eisenhardt & Tabrizi, 1995; Baines et al., 2009).

Second, **capabilities matter**. Absorptive capacity, combinative capabilities, and dynamic capabilities enable firms to leverage external knowledge, reconfigure resources, and pivot in response to technological change (Zahra & George, 2002; Kogut & Zander, 1992; Teece et al., 1997). Managers should therefore invest in learning infrastructures: training, boundary roles, collaborative platforms, and metrics that promote cross-unit knowledge flow.

Third, **governance is central**. Effective IT/digital governance frameworks align decision rights and investment incentives, while platform governance shapes ecosystem behavior (Weill & Ross, 2004; Gawer & Cusumano, 2002). Governance must strike a careful balance between central control (for risk management and standards) and decentralized autonomy (for local innovation and speed).

Fourth, **sustainability and ethics are no longer optional**. Technology managers must account for environmental impacts, data ethics, and social consequences. Lifecycle thinking and servitization offer pathways to align technology strategy with sustainability and recurrent revenue models (Baines et al., 2009; Pisano, 2015).

Finally, **future challenges and research directions** include AI-native governance (how to govern adaptive algorithms and ML lifecycles), technology portfolio decisions under deep uncertainty (scenario-based roadmapping), socio-technical resilience (integrating cybersecurity with supply chain and human factors), and measuring the long-term returns of platform investments. Empirically, longitudinal and multi-site studies can illuminate how firms develop technology capabilities over time.

For practitioners, the implications are clear: adopt a systems view of technology management; create mechanisms for ambidexterity; invest in absorptive and governance capabilities; and integrate

sustainability into core technology decisions. For scholars, the agenda calls for integrative frameworks that bridge strategy, organization, and socio-technical perspectives to explain how technology practices produce performance in varied contexts.

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