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Reconceptualizing Competitive Advantage in Data-Intensive Firms: How Digital Infrastructure, Algorithmic Learning, and Organizational Data Accumulation Reshape Strategic Positioning in Contemporary Business Environments

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Abstract

The digital transformation of business has given rise to data-intensive firms in which competitive advantage and strategic positioning are no longer adequately explained by traditional resource-based or dynamic-capability theories. This conceptual theory-development paper reconceptualizes competitive advantage as the outcome of three interdependent mechanisms—digital infrastructure, algorithmic learning, and organizational data accumulation. Digital infrastructure functions as the enabling platform for seamless data flows; organizational data accumulation converts raw information into strategic capabilities; and algorithmic learning provides the adaptive engine that translates accumulated data into real-time repositioning. Synthesizing peer-reviewed studies published across leading outlets, the paper identifies critical theoretical gaps in isolated treatments of these constructs. Six formal propositions articulate causal, moderating, and synergistic relationships that produce a novel competitive logic unique to data-intensive environments. The resulting framework advances digital business theory by demonstrating how these elements collectively generate dynamic, ecosystem-level strategic positioning that traditional models cannot capture. Contributions extend to both scholarly understanding of data-driven strategy and managerial imperatives for sustained advantage in hyper-competitive markets.

Keywords Data-intensive firms, Competitive advantage, Digital infrastructure, Algorithmic learning, Organizational data accumulation, Strategic positioning

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Introduction

The emergence of data-intensive firms and the need for reconceptualization of competitive advantage

Contemporary markets are increasingly populated by data-intensive firms whose operations revolve around continuous data generation, storage, and exploitation [1-3]. Unlike conventional organizations, these firms treat data as both raw material and strategic asset, rendering legacy frameworks of competitive advantage insufficient. Bibliometric evidence reveals a decade-long surge in big-data research that nonetheless leaves unresolved the question of how data transforms strategic positioning [1]. Early performance-oriented studies confirm positive links between analytics and outcomes but stop short of theorizing the underlying infrastructural, learning, and accumulation processes that sustain advantage [2, 4-8].

Digital infrastructure as a foundational strategic asset

Digital infrastructure—cloud platforms, data pipelines, and connectivity architectures—has evolved from operational support to a core strategic resource [9-19]. Research demonstrates that infrastructure investments moderate the translation of IT resources into business-unit competitiveness and performance growth, especially when coupled with autonomy [19]. In data-intensive contexts, infrastructure ceases to be a cost center and becomes the indispensable backbone that enables volume, velocity, and variety of data to be harnessed at scale.

Algorithmic learning and organizational adaptation processes

Algorithmic learning integrates machine intelligence with human judgment to create organizational adaptation far beyond traditional learning loops [9]. Studies emphasize the coordination of human and machine learning as a prerequisite for effective organizational learning in complex digital environments [9, 10]. This capability allows firms to sense, interpret, and respond to market signals in real time, thereby converting static data into dynamic strategic action [11].

Organizational data accumulation and capability development

Organizational data accumulation represents the deliberate, longitudinal building of proprietary data repositories and associated analytics capabilities [5, 8]. Value-unlocking research shows that accumulation drivers—data quality, integration, and governance—directly influence business value realization [5]. Yet the literature has not fully explained how accumulation interacts with infrastructure and learning to produce sustained competitive advantage.

Strategic positioning challenges in digitally transformed markets

In digitally transformed markets, strategic positioning requires continuous reconfiguration rather than static placement [18, 20-28]. Platform boundaries and datification dynamics alter power distributions and ecosystem participation [28]. Existing theories fail to integrate the three focal mechanisms into a coherent explanation of how data-intensive firms achieve superior positioning. This paper addresses that gap through systematic synthesis and the development of propositions.

Theoretical Foundations and Literature Synthesis

Competitive advantage in data-driven business models

Empirical and conceptual work consistently links big data analytics to firm performance via dynamic capabilities [2]. Customer analytics capabilities and value-creation pathways further demonstrate how analytics translate into sustained advantage [7]. Mixed-method investigations confirm that big data initiatives yield performance gains only when embedded in organizational routines [8]. These studies collectively establish that data-driven models outperform traditional approaches but leave the infrastructural and learning antecedents undertheorized.

Digital infrastructure as strategic enabler

Infrastructure research underscores its moderating role in converting IT investments into competitive outcomes [19]. When business units possess IT autonomy, infrastructure amplifies performance growth by facilitating data scalability and integration [19]. This stream shifts the conversation from infrastructure as a commodity to infrastructure as a strategic prerequisite for data accumulation.

Algorithmic learning as dynamic organizational capability

MIS Quarterly contributions illuminate algorithmic learning as a multilevel coordination mechanism between human and machine intelligence [9]. Complexity and hyperturbulence demand new IS-strategy perspectives that treat algorithmic processes as central to competitive advantage [10, 12]. Collaborative problem-solving enabled by digital tools further illustrates how algorithmic learning drives innovation outcomes [11]. Emancipatory design perspectives add that algorithmic systems must be intentionally structured to avoid oppressive futures while maximizing adaptive capacity [16].

Processes and value of organizational data accumulation

Big-data value realization debates highlight the necessity of moving beyond volume to purposeful accumulation and governance [17]. Datification fundamentally alters organizational strategy by making data the central object of managerial attention [18]. European-firm assessments and driver analyses confirm that accumulation quality and integration determine value extraction [4, 5]. Technological forecasting studies extend this logic to social and environmental applications, showing that accumulated data can inform predictive sustainability models [20, 23]. **Table 1** clarifies the distinct structural roles and strategic functions of the three mechanisms that collectively generate competitive advantage in data-intensive firms.

Table 1. Structural roles and strategic functions of digital infrastructure, organizational data accumulation, and algorithmic learning

Mechanism	Structural role in the firm	Core processes	Strategic function
Digital infrastructure	Foundational technological architecture enabling large-scale data flows	Cloud platforms, distributed storage, API integration, and real-time pipelines	Enables scalable and continuous data ingestion across organizational and ecosystem boundaries
Organizational data accumulation	Strategic informational resource base generated through repeated interactions	Data collection, integration, governance, and repository development	Converts operational signals into proprietary data assets with path-dependent value
Algorithmic learning	Adaptive analytical capability transforming data into strategic intelligence	Machine learning, predictive modeling, and optimization algorithms	Converts accumulated data into predictive and prescriptive decision support
Integrated triad governance	Coordinated management of infrastructure, data, and learning systems	Data governance frameworks, cross-functional integration, and algorithm oversight	Aligns technological capabilities with strategic decision-making

Gaps in integrated theory and the imperative for new mechanisms

While the above streams provide robust foundations, they remain siloed. No single framework explains how digital infrastructure, algorithmic learning, and organizational data accumulation interact causally and synergistically to reshape competitive advantage and strategic positioning. Bibliometric calls for integrated agendas [1] and multilevel IS-strategy perspectives [12] signal the theoretical vacuum this paper fills. The following section constructs the missing integrative logic.

The Competitive Mechanisms of Data-Enabled Strategic Repositioning: Integrating Digital Infrastructure, Algorithmic Learning, and Organizational Data Accumulation

The theoretical contribution of this study lies in reconceptualizing competitive advantage within data-intensive firms as the emergent outcome of three mutually reinforcing mechanisms: digital infrastructure, organizational data accumulation, and algorithmic learning. Rather than viewing these constructs as independent resources, the framework developed here positions them as interdependent components of a dynamic strategic system that continuously reshapes firm positioning within digitally connected markets. This perspective responds to growing recognition that contemporary competition is increasingly mediated through data flows, computational intelligence, and infrastructural architectures that extend across digital ecosystems [10, 18].

Traditional strategy theories—particularly those grounded in the resource-based view—emphasize the role of valuable, rare, and inimitable resources in sustaining competitive advantage. Yet the emergence of data-intensive firms has exposed limitations in static interpretations of strategic resources. Data assets differ fundamentally from traditional resources because they are non-rivalrous, continuously generated, and algorithmically transformable. Their value, therefore, depends not solely on their existence but also on the systems capable of capturing, integrating, and learning from them [4, 5]. Consequently, competitive advantage increasingly derives from the dynamic orchestration of infrastructural capacity, cumulative data assets, and algorithmic intelligence rather than from isolated resource ownership.

Within this architecture, digital infrastructure functions as the structural backbone of the data-intensive firm. It comprises distributed computing platforms, cloud architectures, real-time data pipelines, and interoperable application interfaces that enable continuous data ingestion and processing. Such infrastructures significantly reduce the friction associated with large-scale data capture and integration, allowing organizations to accumulate data across operational, transactional, and ecosystem interactions [19]. As firms scale their infrastructures, they increasingly operate as continuous sensing systems, capable of detecting signals from customers, markets, and partners in real time.

The second mechanism, organizational data accumulation, represents the expanding informational resource base generated through these infrastructures. Data accumulation refers not only to the quantity of stored information but also to the organizational capability to systematically capture, curate, and integrate heterogeneous datasets over time. Through repeated interactions with users, partners, and digital environments, firms progressively construct data repositories that encode behavioral patterns, operational knowledge, and market intelligence [2, 8]. These repositories become strategically valuable because they exhibit strong path dependency and learning effects, making them difficult for competitors to replicate.

However, the mere accumulation of data does not automatically produce a strategic advantage. Data assets become valuable only when they are translated into predictive insight and decision-support capabilities. This transformation occurs through the third mechanism: algorithmic learning. Machine learning, predictive analytics, and automated optimization models convert raw data into continuously improving predictive and prescriptive capabilities [9, 11]. Through iterative training, algorithms identify patterns in large datasets, enabling organizations to forecast demand, optimize operations, and personalize offerings with greater accuracy.

Algorithmic learning, therefore, acts as the adaptive engine of the system. It enables organizations to transform historical data into forward-looking intelligence that informs strategic decision-making. Firms that possess advanced algorithmic capabilities can generate insights from data at a speed and scale that rivals cannot easily match, thereby amplifying the strategic value of accumulated data resources [10, 16]. In this way, algorithmic learning transforms static information repositories into dynamic knowledge systems capable of guiding continuous strategic repositioning.

Together, digital infrastructure, organizational data accumulation, and algorithmic learning form a recursive capability cycle. Infrastructure enables the capture and integration of data streams; accumulated data provides the training substrate for algorithms; and algorithmic insights guide future infrastructure deployment and data acquisition strategies. The resulting feedback loop produces an accelerating process of capability development in which each mechanism strengthens the others.

Figure 1 illustrates the recursive mechanism through which digital infrastructure, organizational data accumulation, and algorithmic learning jointly produce continuous strategic repositioning in data-intensive firms.

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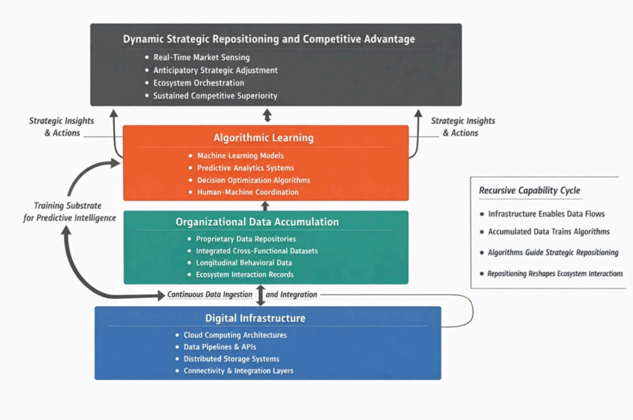

Figure 1. Conceptual architecture of data-enabled strategic repositioning in data-intensive firms. Digital infrastructure enables large-scale data accumulation, which provides the informational substrate for algorithmic learning. Through recursive feedback loops, these mechanisms collectively generate continuous strategic repositioning and sustained competitive advantage in digitally connected markets.

This triadic interaction fundamentally alters the nature of competition in digitally connected markets. Rather than competing through static product positioning or resource endowments, data-intensive firms compete by continuously repositioning themselves with real-time intelligence derived from their data ecosystems. As firms accumulate more data and refine their algorithms, they gain an increasingly granular understanding of customer behavior, operational performance, and ecosystem dynamics. This capability allows them to anticipate market shifts and respond more rapidly than rivals operating with less integrated data infrastructures.

Proposition 1

Digital infrastructure constitutes the structural foundation that enables large-scale organizational data accumulation within data-intensive firms. Modern digital infrastructures—including cloud computing environments, distributed databases, high-throughput data pipelines, and interoperable application programming interfaces—significantly reduce the technical and organizational friction associated with data capture, storage, and integration. These infrastructures enable firms to continuously ingest data from diverse sources, such as customer transactions, platform interactions, supply-chain sensors, and digital ecosystems. As the cost and complexity of data ingestion decline, organizations can accumulate far larger and more diverse datasets than firms without comparable infrastructure.

The accumulation of data through these infrastructures gradually produces an expanding informational resource base that strengthens competitive advantage. As firms repeatedly interact with customers and partners through digital channels, they capture detailed behavioral and operational signals that accumulate over time. These accumulated datasets generate informational asymmetries because they encode historical patterns of demand, operational performance, and market responses that competitors without comparable infrastructures cannot easily observe or replicate. Infrastructure, therefore, enables firms to move beyond episodic data collection toward continuous data generation, creating a persistent stream of information that supports real-time analytics and strategic decision making.

Moreover, digital infrastructure enables the integration of heterogeneous data sources, allowing organizations to combine transactional data, behavioral analytics, operational metrics, and external environmental signals within unified analytical environments. The resulting datasets provide a multidimensional view of market dynamics and organizational performance, enabling more accurate forecasting and more effective operational optimization. As accumulation increases, firms reach thresholds at which analytical techniques such as machine learning and predictive modeling become significantly more effective, generating superior market insight and operational efficiency. In this sense, infrastructure not only enables data collection but also creates the conditions under which accumulated data becomes strategically valuable.
Digital infrastructure enables data-intensive firms to accumulate organizational data, which, in turn, directly strengthens competitive advantage by providing scalable, real-time data assets unavailable to non-infrastructured competitors. Grounded in infrastructure-as-strategic-asset research [19] and big-data value drivers [4, 5], the proposition posits that infrastructure removes friction in data ingestion and storage, allowing accumulation to reach thresholds where analytics yield superior market insight and operational efficiency [2, 8].

Proposition 2

While data accumulation provides an essential information resource, the strategic value of accumulated data depends heavily on the organization's ability to extract meaningful insights from it. Algorithmic learning serves this role by transforming raw data into predictive and prescriptive intelligence. Machine learning models, predictive analytics systems, and optimization algorithms analyze historical data patterns to generate forecasts, recommendations, and automated decision rules. Through iterative learning processes, these algorithms continuously improve their predictive accuracy as additional data becomes available.

Algorithmic learning, therefore, acts as a moderating capability that determines the extent to which accumulated data translates into competitive advantage. Firms with advanced algorithmic capabilities can identify subtle patterns within their datasets, uncover hidden correlations, and generate more precise predictions regarding customer behavior, market demand, and operational performance. In contrast, organizations lacking sophisticated algorithmic tools may possess substantial data repositories but remain unable to derive significant strategic value from them.

The moderating role of algorithmic learning also underscores the growing importance of human–machine coordination in modern organizations. Managers and decision-makers increasingly rely on algorithmic systems to interpret complex data environments and to guide strategic decisions. These systems augment human analytical capabilities by processing massive datasets at speeds and levels of complexity beyond human cognitive capacity. As algorithmic sophistication increases, organizations can leverage accumulated data more effectively, enabling them to identify emerging opportunities and respond to market changes with greater agility.

Consequently, the relationship between data accumulation and competitive advantage is not linear but conditional upon the analytical capabilities available within the firm. Organizations with advanced algorithmic learning systems can extract significantly greater value from equivalent data than competitors without such capabilities. This amplification effect enables algorithmically sophisticated firms to reposition themselves strategically with greater speed and precision.
Algorithmic learning moderates the relationship between organizational data accumulation and competitive advantage such that higher algorithmic sophistication amplifies the strategic value of accumulated data, enabling more precise and agile repositioning. Supported by human-machine coordination studies [9] and innovation-through-search research [11], algorithmic learning transforms static data reservoirs into dynamic predictive and prescriptive capabilities, thereby elevating advantage beyond mere accumulation volume [10, 16].

Proposition 3

Digital infrastructure and algorithmic learning do not operate in isolation; rather, they interact synergistically to accelerate the processes by which organizations accumulate and exploit data. Infrastructure provides the computational capacity and architectural connectivity to capture, store, and process large-scale datasets, while algorithmic learning provides the analytical intelligence to interpret them. When these mechanisms operate together, they create a mutually reinforcing cycle in which infrastructure facilitates algorithmic experimentation and algorithms guide more efficient data acquisition.

This synergy accelerates the accumulation of organizational data in several ways. First, algorithmic systems can identify which data sources are most valuable, allowing firms to prioritize the collection of strategically relevant information. Second, algorithms can automate many aspects of data processing, including data cleaning, classification, and feature extraction, thereby reducing the costs associated with large-scale data management. Third, algorithmic insights often generate new hypotheses about market behavior or operational processes, prompting organizations to collect additional data to test and refine them.

The interaction between infrastructure and algorithms, therefore, creates a self-reinforcing cycle of accumulation. As organizations deploy more sophisticated infrastructures, they generate larger volumes of data that feed into algorithmic learning processes. Improved algorithms then enhance the firm's ability to interpret these data streams, producing insights that inform further infrastructure investments and data acquisition strategies. Over time, this recursive cycle generates exponential growth in both data resources and analytical capabilities.

From a strategic perspective, the combined effect of infrastructure and algorithmic learning produces advantages that exceed the sum of their individual contributions. Firms that master both mechanisms simultaneously can generate insights faster, learn from market signals more effectively, and adapt their strategies more rapidly than competitors operating with less integrated technological systems. This multiplicative effect reshapes ecosystem positioning by enabling firms to anticipate market developments and respond proactively. The synergistic interaction between digital infrastructure and algorithmic learning accelerates organizational data accumulation, generating a multiplicative effect on competitive advantage that exceeds the sum of the individual contributions. The complexity and datification literature [10, 18] and value-realization debates [17] indicate that infrastructure provides the pipes, while algorithms provide the intelligence; together, they create self-reinforcing accumulation cycles that reshape ecosystem positioning [28, 29].

Figure 2 illustrates the dynamic process through which digital infrastructure, data accumulation, and algorithmic learning interact to produce continuous strategic repositioning in data-intensive firms.

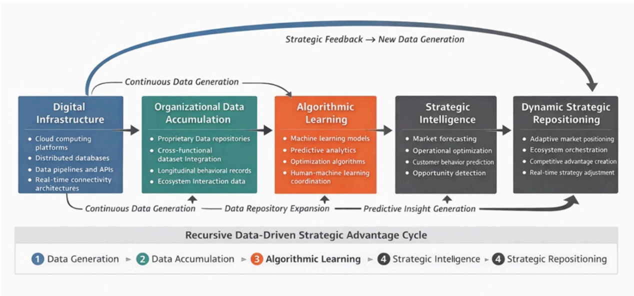

Figure 2. Dynamic process of data-enabled strategic repositioning in data-intensive firms

Proposition 4

Although digital infrastructure plays a crucial enabling role, its strategic value depends on how effectively organizations translate infrastructural capabilities into data accumulation processes. Investments in infrastructure alone do not automatically generate competitive advantage. Firms may deploy advanced computing platforms and storage architectures without realizing significant performance gains if these infrastructures are not accompanied by systematic mechanisms for capturing and integrating data across organizational activities.

Organizational data accumulation, therefore, serves as a mediating mechanism linking infrastructural investment to strategic outcomes. Infrastructure creates the technical capacity for data collection, but competitive advantage emerges only when firms actively use that capacity to build extensive, strategically relevant data repositories. This accumulation process requires deliberate organizational practices, including data governance frameworks, standardized data integration protocols, and cross-functional collaboration between technical and managerial units.

Through sustained accumulation, firms develop data repositories that capture long-term patterns of behavior, operational performance, and environmental change. These repositories enable organizations to perform more sophisticated analyses, generate more accurate predictions, and implement more effective strategic responses. In this way, data accumulation transforms infrastructural capacity into actionable intelligence that can improve organizational performance.

Empirical research on analytics value pathways suggests that firms deriving significant returns from digital technologies are those that integrate infrastructure with data accumulation processes and analytical capabilities. Without such integration, infrastructure remains underutilized and produces limited strategic impact. Consequently, organizational data accumulation mediates the relationship between infrastructure investments and sustained competitive advantage.
Organizational data accumulation mediates the effect of digital infrastructure investments on sustained competitive advantage in data-intensive firms. Evidence from performance-growth models [19] and analytics-value pathways [2, 7] shows that infrastructure alone produces limited returns; only when channeled into purposeful accumulation does it translate into measurable strategic superiority.

Proposition 5

Algorithmic learning not only amplifies the value of accumulated data but also enhances the strategic positioning outcomes derived from it. As machine learning systems process historical datasets, they generate predictive insights into customer preferences, market dynamics, and operational performance. These insights allow firms to anticipate changes in demand, identify emerging opportunities, and adjust their strategies before competitors recognize similar signals.

The predictive capabilities generated by algorithmic learning create significant strategic advantages in environments characterized by uncertainty and rapid technological change. Firms equipped with advanced learning systems can identify weak signals within complex data environments and convert them into actionable strategic intelligence. This capacity enables organizations to move beyond reactive decision-making toward anticipatory strategy formation, thereby preempting market shifts and shaping competitive dynamics.

Algorithmic learning also facilitates continuous strategic refinement. As new data becomes available, learning algorithms update their predictive models, allowing organizations to refine their strategies in real time. This iterative learning process creates adaptive capabilities that enable firms to respond quickly to environmental changes and maintain alignment with evolving market conditions. In turbulent environments, such adaptive capacity can produce significant first-mover advantages by enabling firms to act on emerging opportunities before rivals. Algorithmic learning enhances the strategic positioning outcomes of organizational data accumulation by enabling continuous refinement and predictive foresight, allowing data-intensive firms to preempt market shifts more effectively than rivals. Machine-learning coordination [9] and emancipatory algorithmic design [16] demonstrate that learning loops convert accumulated data into forward-looking repositioning moves, creating first-mover advantages in turbulent environments [12].

Proposition 6

The preceding propositions collectively suggest that competitive advantage in data-intensive firms emerges not from individual technological components but from the integrated governance of digital infrastructure, algorithmic learning, and organizational data accumulation. Effective governance ensures that these mechanisms operate as a coordinated strategic system rather than as disconnected technological investments. Governance structures define how data is collected, how algorithms are deployed, and how insights are translated into organizational decisions.

Integrated governance also extends beyond the firm's boundaries. In digitally connected markets, firms increasingly operate within platform ecosystems where value is created through interactions among multiple actors, including customers, developers, suppliers, and complementors. Within such ecosystems, firms possessing advanced data infrastructures and learning capabilities can influence the flow of information and shape the rules governing platform participation.

This ecosystem-level influence redefines traditional conceptions of strategic positioning. Rather than competing solely through product differentiation or cost advantages, data-intensive firms compete by orchestrating informational flows and coordinating interactions among ecosystem participants. Through data governance frameworks, algorithmic decision systems, and infrastructure control points, these firms can shape market dynamics beyond the organization's direct boundaries.

Consequently, strategic positioning becomes less about occupying a fixed position within an industry structure and more about orchestrating interactions across digitally connected ecosystems. Firms that master the governance of infrastructure, data, and algorithms thereby gain the ability to exercise non-hierarchical influence over market dynamics, fundamentally altering the nature of competition in digital economies.
Integrated governance of digital infrastructure, algorithmic learning, and organizational data accumulation constitutes a novel competitive mechanism that redefines strategic positioning as ecosystem-level orchestration rather than firm-level placement. Platform-boundary and datification perspectives [18, 28] together with sustainability-oriented forecasting [20] illustrate that firms mastering this triad achieve non-hierarchical influence across digitally connected markets, rendering traditional positioning frameworks obsolete.

Taken together, these six propositions articulate a systemic model of data-enabled strategic repositioning. Competitive advantage emerges not from isolated technological resources but from the coordinated interaction of infrastructure, data accumulation, and algorithmic learning within an integrated governance framework. This perspective moves beyond additive models of digital capability toward a dynamic systems understanding of strategic advantage, in which feedback loops among technological, informational, and analytical mechanisms continuously reshape firm positioning.

The framework, therefore, provides theoretical closure for previously fragmented streams of research on digital infrastructure, big data analytics, and algorithmic strategy. By integrating these constructs within a unified conceptual model, the study clarifies how data-intensive firms generate sustained competitive advantage in digitally mediated markets and establishes a foundation for future empirical investigation.

Reconfiguring Strategic Logic Through Interdependent Data Mechanisms: Theoretical Extensions for Competitive Advantage in Data-Intensive Firms

The propositions advanced in the preceding section extend existing theory by shifting the locus of competitive advantage from isolated resources or capabilities to a tightly coupled triad operating at organizational and ecosystem levels. Traditional resource-based and dynamic-capability perspectives treat infrastructure, learning, and data stocks as independent antecedents [2, 12]. The present framework demonstrates that their interdependence creates emergent properties—continuous repositioning velocity and ecosystem orchestration—that cannot be reduced to additive effects. By integrating infrastructure-as-strategic-asset research [19] with multilevel algorithmic coordination [9, 10] and datification strategy [18], the model resolves the theoretical fragmentation documented in bibliometric reviews [1] and value-realization debates [17]. **Table 2** contrasts the logic of traditional competitive advantage with the data-enabled strategic repositioning model proposed in this study.

Table 2. Comparative strategic logics: traditional competitive advantage vs data-enabled competitive advantage

Dimension	**Traditional competitive strategy**	**Data-enabled competitive strategy**
Primary strategic resource	Tangible assets and proprietary capabilities	Continuous data flows and analytical intelligence
Role of technology	Operational support tool	Core strategic infrastructure
Learning mechanism	Human managerial learning	Integrated human–machine algorithmic learning
Source of advantage	Resource scarcity and differentiation	Data accumulation and predictive insight
Competitive dynamics	Periodic repositioning within the industry structure	Continuous repositioning through real-time analytics
Organizational scope	Firm-centric competition	Ecosystem-level orchestration
Strategic time horizon	Long cycles of strategic adjustment	Continuous adaptive repositioning

This reconceptualization further contributes by elevating organizational data accumulation from a passive stock to an active mediator that converts infrastructural investments into sustained advantage [4, 5, 19]. It also positions algorithmic learning as the critical moderator that prevents data from becoming a liability, thereby addressing calls for emancipatory algorithmic design [16]. At the ecosystem level, Proposition 6 reframes strategic positioning as non-hierarchical governance across platform boundaries [28], offering a novel explanation for how data-intensive firms achieve influence without ownership. Collectively, these extensions move digital business theory from firm-centric to mechanism-centric explanations, providing a parsimonious yet comprehensive logic for advantage in hyper-turbulent, data-saturated markets.

Orchestrating Data-Enabled Supremacy: Managerial Pathways for Infrastructure, Learning, and Accumulation Integration

Managers in data-intensive firms must abandon siloed technology initiatives and adopt integrated governance that aligns digital infrastructure, algorithmic learning, and organizational data accumulation as a single strategic operating system. First, infrastructure investments should be evaluated not merely for scalability but for their capacity to accelerate data ingestion pipelines that feed accumulation loops [19]. Executive teams should mandate cross-functional data architecture reviews that embed algorithmic feedback mechanisms from day one, ensuring that every new cloud node or API layer directly supports learning cycles [9].

Second, capability development programs must prioritize human–machine coordination routines [9, 11]. Training should shift from analytics literacy to joint decision-making protocols in which managers and algorithms iteratively refine positioning hypotheses. Firms that institutionalize these routines—through dedicated “learning sprints” tied to real-time market signals—will realize the moderating amplification described in Proposition 2. Third, data accumulation strategies must move beyond volume metrics to quality-governance dashboards that track integration completeness and predictive utility [5, 17]. Leaders should establish accumulation thresholds (e.g., proprietary datasets reaching critical mass for ecosystem forecasting) as key performance indicators, directly linking them to repositioning agility [20].

Finally, platform-oriented firms should design governance structures that treat the triad as the core of ecosystem orchestration [28]. This entails transparent data-sharing protocols with partners while retaining algorithmic control internally, thereby converting external connections into internal advantage multipliers. Organizations implementing these pathways will convert the propositions into measurable superiority in customer insight, operational responsiveness, and market preemption.

Uncharted Frontiers in Data-Intensive Strategy: Directions for Advancing Algorithmic Adaptation and Ecosystem Positioning Research

Although the current framework closes critical conceptual gaps, several avenues remain open for future inquiry. Longitudinal field studies could test the temporal sequencing of the proposed mechanisms—specifically, whether infrastructure must precede accumulation or whether early algorithmic learning can bootstrap both. Multi-industry comparisons would reveal boundary conditions: for example, whether the multiplicative synergy in Proposition 3 holds equally in regulated sectors versus unregulated digital-native markets.

Cross-ecosystem analyses should examine how the triad influences power distribution beyond firm boundaries, extending platform-boundary research [28] to include non-platform data-intensive actors. Researchers could also investigate dark-side contingencies—such as algorithmic bias amplification or data-accumulation lock-in effects—drawing on emerging emancipatory design perspectives [16]. Finally, comparative studies across global contexts would illuminate the cultural and regulatory moderators of learning coordination [9], thereby enriching the framework’s applicability in emerging economies. These directions collectively provide a robust agenda for moving from conceptual synthesis to a validated, multilevel theory of data-driven strategic positioning.

Conclusion

This theory-development manuscript reconceptualizes competitive advantage as an emergent outcome of orchestrated digital infrastructure, algorithmic learning, and organizational data accumulation. The six propositions articulate precise causal, mediating, and synergistic relationships that produce continuous, ecosystem-level strategic repositioning unavailable to firms relying on traditional logics. The framework resolves longstanding theoretical silos and supplies both scholars and practitioners with an actionable explanation of advantage in contemporary data-saturated markets.

The paradigm shift is clear: sustained superiority now resides not in owning superior resources but in mastering the interdependent mechanisms that continuously convert data flows into positional agility. Firms that internalize this logic will lead the next wave of digital transformation; those that do not risk obsolescence. The proposed mechanisms thus offer a forward-looking foundation for digital business and management studies in an era defined by data intensity.

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References

Zhang Y, Zhang M, Li J, Liu G, Yang MM, Liu S. A bibliometric review of a decade of research: Big data in business research–Setting a research agenda. J Bus Res. 2021;131:374-90.

Wamba SF, Gunasekaran A, Akter S, Ren SJ, Dubey R, Childe SJ. Big data analytics and firm performance: Effects of dynamic capabilities. J Bus Res. 2017;70:356-65.

Mazzucchelli A, Gurioli M, Graziano D, Quacquarelli B, Aouina-Mejri C. How to fight against food waste in the digital era: Key factors for a successful food sharing platform. J Bus Res. 2021;124:47-58.

Côrte-Real N, Oliveira T, Ruivo P. Assessing business value of big data analytics in European firms. J Bus Res. 2017;70:379-90.

Watson R, Wilson HN, Macdonald EK. Business-nonprofit engagement in sustainability-oriented innovation: what works for whom and why? J Bus Res. 2020;119:87-98.

Gligor DM, Gopalakrishna Pillai K, Golgeci I. Theorizing the Dark Side of Business-to-Business Relationships in the era of AI, Big Data, and Blockchain. J Bus Res. 2021;133:79-88.

Hossain MA, Akter S, Yanamandram V. Why doesn't our value creation payoff: Unpacking customer analytics-driven value creation capability to sustain competitive advantage. J Bus Res. 2021.

Mikalef P, Boura M, Lekakos G, Krogstie J. Big data analytics and firm performance: findings from a mixed-method approach. J Bus Res. 2019;98:261-76.

Sturm T, Gerlach JP, Pumplun L, Mesbah N, Peters F, Tauchert C, et al. Coordinating human and machine learning for effective organizational learning. MIS Q. 2021;45(3):1581-602.

Benbya H, Nan N, Tanriverdi H, Yoo Y. Complexity and information systems research in the emerging digital world. MIS Q. 2020;44(1):1-8.

Karhade PP, Dong JQ. Innovation outcomes of digitally enabled collaborative problemistic search capability. MIS Q. 2021;45(2):693-718.

Nan N, Tanriverdi H. Unifying the Role of IT in Hyperturbulence and Competitive Advantage Via a Multilevel Perspective of IS Strategy. MIS Q. 2017;41(3):937-58.

Brynjolfsson E, Wang C, Zhang X. The economics of IT and digitization: Eight questions for research. MIS Q. 2021;45(1):473-7.

Bardhan I, Chen H, Karahanna E. Connecting systems, data, and people: A multidisciplinary research roadmap for chronic disease management. MIS Q. 2020;44(1):185-200.

Zhang W, Ram S. A comprehensive analysis of triggers and risk factors for asthma based on machine learning and large heterogeneous data sources. MIS Q. 2020;44(1):305-50.

Kane GC, Young AG, Majchrzak A, Ransbotham S. Avoiding an oppressive future of machine learning: A design theory for emancipatory assistants. MIS Q. 2021;45(1):371-96.

Günther WA, Mehrizi MHR, Huysman M, Feldberg M. Debating big data: a literature review on realizing value from big data. J Strateg Inf Syst. 2017;26(3):191-209.

Markus ML. Datification, organizational strategy, and IS research: what's the score? J Strateg Inf Syst. 2017;26(3):273-85.

Queiroz M, Tallon PP, Coltman T, Sharma R. Digital infrastructure, business unit competitiveness, and firm performance growth: the moderating effects of business unit IT autonomy. In: Hawaii International Conference on System Sciences; 2020.

Dubey R, Gunasekaran A, Childe SJ, Papadopoulos T, Luo Z, Wamba SF, et al. Can big data and predictive analytics improve social and environmental sustainability? Technol Forecast Soc Change. 2019;144:534-45.

Gordon AV, Ramic M, Rohrbeck R, Spaniol MJ. 50 Years of corporate and organizational foresight: Looking back and going forward. Technol Forecast Soc Change. 2020;154:119966.

Kim J, Geum Y. How to develop data-driven technology roadmaps: The integration of topic modeling and link prediction. Technol Forecast Soc Change. 2021;171:120972.

Blazquez D, Domenech J. Big Data sources and methods for social and economic analyses. Technol Forecast Soc Change. 2018;130:99-113.

Huang Y, Porter AL, Cunningham SW, Robinson DK, Liu J, Zhu D. A technology delivery system for characterizing the supply side of technology emergence: Illustrated for Big Data & Analytics. Technol Forecast Soc Change. 2018;130:165-76.

Yu X, Zhang B. Obtaining advantages from technology revolution: A patent roadmap for competition analysis and strategy planning. Technol Forecast Soc Change. 2019;145:273-83.

Fernández-Rovira C, Valdés JÁ, Molleví G, Nicolas-Sans R. The digital transformation of business. Towards the datafication of the relationship with customers. Technol Forecast Soc Change. 2021;162:120339.

Bailey D, Faraj S, Hinds P, von Krogh G, Leonardi P. Special issue of organization science: Emerging technologies and organizing. Organ Sci. 2019;30(3):642-6.

Gawer A. Digital platforms' boundaries: The interplay of firm scope, platform sides, and digital interfaces. Long Range Plann. 2021;54(5):102045.

Mao C, Koide R, Brem A, Akenji L. Technology foresight for social good: Social implications of technological innovation by 2050 from a Global Expert Survey. Technol Forecast Soc Change. 2020;153:119914.