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DIGITAL TRANSFORMATION AND SUSTAINABLE VALUE CREATION AT BYD

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ABSTRACT

The expansion of new energy vehicle manufacturing creates a strategic challenge: firms must increase output while maintaining resource efficiency, product quality and credible environmental accountability. This article develops a sustainable value creation framework for BYD, connecting digital capabilities with operational decisions and measurable economic, environmental and social outcomes. The study uses a qualitative, documentary case approach anchored in BYD's 2024 sustainability report and established research on digital transformation, dynamic capabilities and sustainable business models. Four pathways are proposed: digitally enabled production control, supply-chain visibility, knowledge integration and lifecycle accountability. The analysis distinguishes disclosed corporate practices from proposed mechanisms and avoids attributing environmental improvements to digitalization without operational evidence. A measurement matrix and staged implementation roadmap translate the framework into managerial decisions. The central proposition is that digital investment creates sustainable value only when information is converted into accountable organizational action and evaluated against both intensity and absolute environmental indicators. The framework provides a basis for future empirical testing in new energy vehicle firms operating within renewable energy ecosystems.

KEYWORDS: *digital transformation; sustainable value creation; BYD; new energy vehicles; dynamic capabilities; lifecycle management.*

1. INTRODUCTION

Electrification changes the environmental profile of mobility but does not eliminate the impacts associated with industrial production. Battery materials, electricity consumption, logistics and end-of-life management remain important sources of environmental pressure. A manufacturer therefore faces a dual task: delivering commercially attractive vehicles and managing the consequences of producing them at scale. Digital transformation is relevant because it can improve the quality, speed and traceability of decisions across these activities. Its contribution, however, depends on how technologies are embedded in organizational routines rather than on the mere presence of advanced equipment.

2. RESEARCH PROBLEM AND OBJECTIVES

The research problem concerns the gap between digital capability and demonstrated sustainability performance. A company can introduce monitoring systems, connected equipment and data platforms without establishing whether these investments reduce material waste or improve working conditions. Conversely, sustainability improvements can result from changes in the electricity mix, product design or production volume rather than digital interventions. A credible analysis must therefore identify the intermediate decisions through which digital information could influence outcomes.

BYD provides a relevant setting because its activities connect vehicle manufacturing, battery technology and energy-related products. The case offers an opportunity to examine the interface between industrial operations and the broader transition toward electrified mobility. The purpose is not to rank BYD against competitors, but to develop a mechanism-based explanation that can be tested using more detailed operational evidence.

The first objective is to identify digital capabilities relevant to sustainable value creation. The second is to link those capabilities to decision processes in production, procurement, innovation and lifecycle management. The third is to design indicators that separate operational improvement from changes caused by business expansion. The fourth is to offer a practical implementation roadmap and identify conditions under which the expected benefits may not materialize.

Three research questions guide the analysis. RQ1: Through which organizational mechanisms can digital transformation support sustainable value creation in an integrated new energy vehicle firm? RQ2: Which indicators would provide credible evidence that these mechanisms are working? RQ3: What organizational and governance safeguards are needed to prevent digital investments from creating new environmental or social risks?

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2.1 Scope and contribution

The unit of analysis is the corporate operating system rather than an individual vehicle model. Sustainability is interpreted as the ability to maintain economic viability while reducing harmful environmental effects and protecting legitimate stakeholder interests. Sustainable value creation is thus wider than profitability or sales growth. It includes improvements that persist across business cycles and do not simply transfer costs from one organizational unit to another.

The contribution is a diagnostic framework that places managerial action between technology adoption and sustainability outcomes. The framework is designed for subsequent testing, not presented as an already validated causal model. It offers a way to organize corporate evidence, select performance indicators and formulate investment decisions while acknowledging the limitations of public disclosures.

3. LITERATURE REVIEW AND THEORETICAL FOUNDATIONS

Vial (2019) conceptualizes digital transformation as a process in which combinations of digital technologies trigger changes in organizations and their value creation arrangements. This perspective distinguishes transformation from digitization, which may only convert existing records into digital form. For a manufacturing enterprise, transformation entails changing how information travels between engineering, production, procurement and management.

Bharadwaj et al. (2013) argue that digital business strategy involves a closer integration of information technology and business strategy. This integration is especially important where equipment, software and organizational knowledge are complementary assets. An isolated analytics project may generate useful results but fail to alter resource allocation or operating standards if it is not connected to business priorities.

The dynamic capabilities perspective helps explain variation in outcomes. Teece (2007) distinguishes sensing opportunities, seizing them and reconfiguring resources. In an industrial setting, sensing could involve recognizing abnormal energy demand or emerging supplier risk. Seizing involves selecting an intervention, assigning responsibility and funding implementation. Reconfiguration requires embedding the improved process in training, maintenance routines and technical standards. The three stages provide a bridge between information and action.

Sustainable business model research extends the analysis beyond operational efficiency. Bocken et al. (2014) identify patterns through which business models may reduce resource demand and create broader social or environmental benefits. Hart (1995) emphasizes the strategic relevance of pollution prevention, product stewardship and sustainable development. Together these perspectives suggest that firms need to examine both internal resource use and impacts that arise elsewhere in the product lifecycle. The triple bottom line perspective also cautions against evaluating an intervention by financial savings alone (Elkington, 1997). Automated production may reduce defects while introducing workforce reskilling needs. A more efficient component may require materials with difficult upstream sourcing conditions. Sustainability therefore requires an explicit account of trade-offs rather than an assumption that every performance measure improves together.

The resulting theoretical synthesis identifies digital information as an enabling resource, dynamic capabilities as the conversion mechanism and sustainable value as a multidimensional outcome. The relationship is conditional on governance, workforce capacity and the physical characteristics of manufacturing. These conditions are particularly relevant where capital-intensive assets constrain the speed of organizational change.

4. RESEARCH METHODOLOGY

This article adopts an exploratory single-case design informed by Yin (2018). The primary documentary source is BYD's sustainability report for 2024, published in 2025. The analysis is intentionally bounded to that reporting period; it does not claim to describe every development occurring after 2024. The report provides corporate-level context for environmental management, responsible sourcing, product quality and workforce development. Academic literature supplies concepts for interpreting how digital capabilities may support these activities.

The analytical procedure comprises three steps. First, the report's thematic areas are used to identify sustainability-related decision domains. Second, each domain is mapped to a proposed digital capability and an intermediate organizational action. Third, a candidate indicator is selected to evaluate the outcome and identify alternative explanations. The resulting matrix is an author-developed conceptual instrument rather than a dataset extracted from internal BYD systems.

Evidence Category	Use in the analysis	Interpretive boundary
Corporate disclosure	Identify reported practices and priorities	Management reporting; not causal evidence
Academic literature	Explain plausible mechanisms	Theory does not establish BYD-specific effects
Proposed indicators	Design future measurement	No observed values are claimed
Comparative baseline	Specify future testing conditions	No plant-level comparison is available

Table 1. Evidence classification and analytical boundaries. Source: authors' framework.

Documentary research is appropriate when internal production logs, supplier records and interview data are not accessible. Its principal weakness is limited visibility into implementation quality and the timing of individual investments. Corporate disclosures may emphasize achievements and omit unsuccessful projects. To reduce overinterpretation, this study uses conditional language for proposed digital practices and reserves factual claims for information supported by the cited report.

No questionnaires, interviews, experimental observations or econometric estimates are reported. A future empirical study should obtain production-line observations before and after specific interventions, document changes in output and product mix, and compare equivalent facilities where feasible. This would permit a stronger assessment of whether digital transformation contributes independently to observed results.

5. BYD CASE CONTEXT AND PRODUCTION PATHWAY

BYD operates at the intersection of electrified transport and battery-related manufacturing. Its 2024 sustainability report organizes corporate responsibilities around environmental performance, product quality, workforce development, responsible supply chains and governance (BYD, 2025). These domains offer a useful basis for investigating sustainable value creation because they connect engineering decisions with stakeholder outcomes. They should not, however, be treated as proof that any particular digital system has delivered a quantified benefit.

5.1 Digitally enabled production control

Production control constitutes the first proposed pathway. Connected measurement systems can potentially make energy consumption, equipment condition and quality deviations visible at the level of individual processes. The managerial relevance of such information lies in the ability to distinguish recurring inefficiencies from isolated disturbances. For example, a rise in electricity demand during periods of low output might prompt engineers to investigate idle equipment or inappropriate operating settings.

A useful control cycle begins with calibrated measurement, proceeds through anomaly detection and assigns a responsible employee to investigate the deviation. Once a corrective action is implemented, subsequent observations determine whether the process has stabilized. The digital system delivers value only if the organization closes this control loop. A dashboard without responsibility or corrective authority is unlikely to change performance.

Quality management provides a related opportunity. Defective components embody wasted material, electricity and labor. Linking inspection records to upstream process conditions could help engineering teams identify recurring patterns. A successful intervention should be judged by changes in first-pass yield and scrap per conforming unit, rather than by inspection volume or the number of automated alerts.

The environmental outcome requires separate scrutiny. Reducing energy per vehicle does not necessarily reduce total energy demand when output grows. Both absolute energy consumption and energy intensity should therefore be reported. Changes in product specifications, production utilization and electricity supply should also be considered before attributing an improvement to digital control.

Proposition 1: Digitally enabled production visibility supports sustainable value creation when reliable observations are linked to corrective action, and when resource savings are assessed relative to comparable output and quality requirements.

6. SUPPLY-CHAIN VISIBILITY AND KNOWLEDGE INTEGRATION

6.1 Responsible Sourcing Pathway

Battery supply chains involve multiple tiers of material extraction, processing and component manufacturing. BYD's 2024 report describes responsible mineral procurement arrangements. Digital traceability could complement such arrangements by associating purchased materials with supplier identifiers, origin records and verification status. The proposed mechanism is not the creation of a database itself, but the incorporation of verified information into supplier selection, risk review and remediation decisions.

A procurement team should distinguish complete records from reliable records. A supplier may submit every requested field while providing information that cannot be independently corroborated. A risk-based review should therefore require stronger verification for higher-risk materials and provide a process for resolving inconsistencies. This helps avoid the misleading appearance of compliance created by high data completion rates alone.

Supplier management must also consider commercial incentives. If procurement rewards only low prices and rapid delivery, sustainability concerns may be displaced despite improved visibility. Balanced supplier scorecards and escalation procedures can connect digital information to contractual decisions. Appropriate measures include verified traceability coverage, corrective-action closure and the recurrence of significant findings.

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6.2 Knowledge integration pathway

A second organizational mechanism concerns the transfer of knowledge between product engineering and factory operations. Digital records can potentially connect design revisions, test outcomes, manufacturing constraints and field-quality feedback. When this information is shared across organizational boundaries, teams may be able to identify design choices that make products easier to manufacture, maintain or repair.

Knowledge integration requires shared definitions and version control. Without them, designers and production engineers may interpret identical indicators differently. Data owners, revision histories and documented engineering approvals can make the decision process more reliable. The appropriate performance measure is not simply the number of shared files, but whether recurring quality problems decline and whether corrective designs are adopted within a reasonable time.

Proposition 2: Supply-chain visibility contributes to sustainable value when verified records influence purchasing and remediation.
Proposition 3: Knowledge integration contributes to sustainable value when engineering and operational feedback leads to documented, measurable improvements in product and process design.

7. LIFECYCLE ACCOUNTABILITY AND INTEGRATED FRAMEWORK

The fourth pathway extends analysis beyond the factory gate. Electric vehicle sustainability depends on the origin of materials, manufacturing conditions, use-phase electricity and end-of-life treatment. Lifecycle thinking, formalized in ISO 14040 and ISO 14044, helps avoid shifting environmental burdens between stages. A digital record of relevant material and product information could support lifecycle assessment, repair decisions and recovery planning, provided that its underlying data are reliable.

For BYD, the conceptual importance of lifecycle accountability derives from the relationship between battery technology and vehicle performance. Decisions that increase durability or facilitate serviceability could affect replacement demand and customer costs. Nevertheless, these benefits must be assessed against actual service records and lifecycle assumptions. A longer theoretical lifetime does not guarantee a longer observed lifetime.

Proposition 4: Lifecycle-oriented information systems support sustainable value creation when relevant data remain accessible across product stages and when design, service and recovery decisions are evaluated against consistent environmental boundaries.

7.1 Mechanism framework

Digital Capability	Organizational Conversion	Potential Value
Process sensing	Investigate deviations; adjust operations	Lower waste and energy intensity
Supplier data integration	Verify origin; remediate risk	Responsible procurement and resilience
Engineering feedback	Revise designs; standardize learning	Quality, durability and productivity
Lifecycle records	Inform service and recovery decisions	Resource preservation and accountability

Table 2. Proposed digital-to-value mechanisms. Source: authors' conceptual synthesis.

The pathways interact. Improved production records can inform engineering revisions; more reliable material data can strengthen lifecycle models. Integration across pathways may therefore be more valuable than isolated investment. However, integration also creates dependencies: errors in shared master data can propagate across multiple functions. Governance should establish who is responsible for correcting records, approving access and validating material decisions.

The framework views economic, environmental and social value as interdependent but not interchangeable. A financial benefit should not automatically offset an environmental violation or a serious safety concern. Decision thresholds should include mandatory safeguards alongside financial evaluation.

8. PERFORMANCE MEASUREMENT AND EVALUATION

A measurement system should connect each investment to a specific operational baseline. The following indicators are proposed for future implementation; they are not reported BYD performance values. Definitions should remain stable across periods and be documented when changes are unavoidable.

Dimension	Proposed Indicator	Definition / Interpretation
Economic	First-pass yield	Conforming units without rework / inspected units
Economic	Cost of poor quality	Scrap, rework and related failure costs
Environmental	Energy intensity	Energy consumed / conforming output
Environmental	Absolute emissions	Total Scope 1 and 2 emissions within a consistent boundary
Environmental	Material yield	Useful material output / material input
Social	Safety incident rate	Recordable incidents per defined work-hour basis
Governance	Verified sourcing coverage	Verified high-risk material volume / in-scope volume
Governance	Corrective action closure	Validated closed actions / actions due

Table 3. Suggested performance indicators. Source: authors' framework; emissions boundary informed by GHG Protocol (2004).

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The evaluation should compare periods using equivalent definitions. Energy intensity can be adjusted for product mix where different models have substantially different production requirements. Absolute emissions should be interpreted alongside electricity procurement and organizational boundary changes. The GHG Protocol provides a foundation for distinguishing direct emissions from purchased-energy emissions, while broader lifecycle analysis considers other categories of impact.

An intervention assessment should specify its implementation date, affected equipment, expected mechanism and competing explanations. If a new production monitoring system is installed during a major capacity expansion, a simple before-and-after comparison may be misleading. A matched production line or interrupted time-series design could improve inference when sufficiently detailed data are available.

The proposed indicators should not be collapsed into a single sustainability score without transparent weighting and sensitivity analysis. Different stakeholders may have legitimate differences in how they value resource savings, working conditions and financial outcomes. A dashboard that retains separate dimensions is more informative for identifying trade-offs and setting priorities.

9. STRATEGIC RECOMMENDATIONS AND IMPLEMENTATION ROADMAP

The first recommendation is to prioritize high-impact decisions rather than technologies. Management should select a process where environmental losses, quality problems or supplier risk are material and where a clear organizational owner can act on information. The project charter should define the baseline, expected benefit, cost and evidence needed to demonstrate success.

The second recommendation is to build data governance into project design. Common units, consistent identifiers, documented calculation methods and access controls should precede large-scale integration. Cybersecurity and operational continuity are particularly important in connected manufacturing environments. A system outage or unauthorized modification of critical records could undermine both productivity and safety.

The third recommendation is to invest in employee capabilities. Operators and engineers need sufficient training to interpret alerts, challenge misleading results and document corrective actions. A participatory implementation process can reveal practical constraints that are not apparent to software designers. Workforce outcomes should be monitored during technology adoption rather than considered only after deployment.

Stage	Priority Action	Decision Gate
0–3 Months	Map data and select pilot process	Baseline and owner approved
3–6 Months	Pilot measurement and corrective workflow	Data quality and safety verified
6–12 Months	Evaluate outcomes and competing factors	Benefits supported by evidence
12–24 Months	Scale proven routines across operations	Independent review and ongoing monitoring

Table 4. Illustrative implementation roadmap; proposed durations are not BYD commitments.

The fourth recommendation is to connect financial evaluation with sustainability safeguards. Investment proposals can estimate avoided waste, downtime and rework while separately reporting environmental and social effects that are difficult to monetize. Projects should be rejected or redesigned if they fail mandatory safety, environmental or data protection requirements, even where projected financial returns are attractive.

The fifth recommendation is to publish transparent methodological notes for performance claims. These should specify the organizational boundary, baseline period, calculation formula and material assumptions. Transparent reporting can strengthen stakeholder confidence and make subsequent independent assessment more feasible.

10. CONCLUSION, LIMITATIONS AND REFERENCES

Digital transformation can support sustainable value creation at BYD through production control, responsible sourcing, engineering knowledge integration and lifecycle accountability. The proposed framework emphasizes the decisions and organizational routines that convert information into outcomes. It also distinguishes resource intensity from absolute impacts, a necessary distinction for expanding manufacturers. The study does not establish causal effects or quantify the return on digital investment. Its documentary basis limits the conclusions to conceptual mechanisms and testable propositions. Future research should use plant-level longitudinal data, comparable operating units and independently verified sustainability measures to test the framework. The practical implication is that digital investments should be evaluated by evidenced changes in operations and stakeholder outcomes rather than by technological sophistication alone

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Data availability: This conceptual case study uses public documentary sources. No proprietary dataset or primary participant data were collected.

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