ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue V May 2025

The Impacts of Digital Transformation on Firm Performance: A Case Study of Tesla Business Model

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DOI: https://doi.org/10.51244/IJRSI.2025.120500023

Received: 23 April 2025; Accepted: 29 April 2025; Published: 30 May 2025

ABSTRACT

With digital transformation accelerating globally, businesses are undergoing major shifts in competitiveness and sustainable growth. This study investigates the impact of digital transformation on firm performance, focusing on smart product innovation, smart manufacturing transformation, and digital-driven customer engagement. Using Tesla as a case study, survey data from 300 respondents was analyzed using SPSS Version 26 for descriptive, correlation, and regression analysis. Results show that all three digital transformation dimensions positively influence firm performance. Smart product innovation significantly enhances financial performance and brand value, while smart manufacturing improves non-financial aspects such as customer satisfaction and operational efficiency. Digital-driven customer engagement contributes to both financial and non-financial outcomes by boosting customer loyalty and user experience. The study also highlights key challenges such as technology costs, organizational resistance, and data security concerns. These findings offer strategic insights for management, especially in the automotive sector, and provide a foundation for future research in digital transformation.

Keywords: Smart product innovation, smart manufacturing transformation, digital-driven customer engagement, firm performance

BACKGROUND OF STUDY

In today's fast-evolving digital landscape, business competition is being reshaped by digital transformation. Once viewed as a mere technological upgrade, digital transformation now encompasses sweeping changes in product development, operations, and business models (Gökalp & Martinez, 2021). Traditional competitive advantages like cost control and brand strength are increasingly complemented or even replaced by digital capabilities. Technologies such as big data analytics, AI, cloud computing, and IoT are enabling firms to streamline operations, enhance customer experiences, and explore new revenue streams (Hou, 2023).

The automotive industry exemplifies this shift. While legacy automakers relied on mass production and dealership networks, the rise of electric vehicles (EVs), connected cars, and autonomous technologies has redefined the competitive landscape. Tesla stands out as a digital transformation pioneer, employing smart connectivity, over-the-air (OTA) updates, direct-to-consumer sales, and software-as-a-service (SaaS) strategies. These innovations have positioned Tesla not just as a carmaker, but as a technology-driven company (Hu et al., 2022).

Tesla's approach has redefined business operations and customer engagement. By bypassing traditional dealerships, Tesla leverages digital platforms to engage consumers directly, reduce intermediaries, and build brand loyalty. OTA updates keep vehicles continuously evolving, enhancing their lifecycle and user experience (Hu et al., 2022). Beyond the automotive sector, digital transformation involves data-driven decision-making, automation, and platform-based operations. Hou (2023) emphasized that competitiveness now hinges more on data and digital ecosystems than on hardware. Zhang et al. (2024) found that digital transformation not only boosts operational efficiency but also drives diversification. Tesla's expansion into energy storage, self-driving software, and charging networks illustrates how digital ecosystems can create new value chains and revenue models.

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Moreover, digitalization improves access to financing. He et al. (2023) noted that firms with strong digital strategies tend to face fewer financing constraints due to increased transparency and investor confidence. In capital-intensive industries like EVs, this can be a crucial advantage. Tesla's ability to attract investment and outperform incumbents owes much to its digital strength. Despite the benefits, implementing digital transformation is not without challenges. High costs, internal resistance, and data security risks are common barriers (Gökalp & Martinez, 2021). Furthermore, transformation outcomes differ across industries and firm sizes. While large multinationals may afford substantial digital investments, SMEs often face financial and technological constraints, requiring more agile and cost-effective strategies.

In this context, digital transformation is not optional whereas it is a strategic imperative. As industries continue to evolve, firms must develop digital capabilities to remain competitive. Understanding how digital transformation drives business model innovation and improves firm performance remains a vital area of academic inquiry and managerial practice (Zhang et al., 2024).

Problem Statement

Digital transformation goes beyond adopting individual technologies as it fundamentally reshapes business models, operations, and value creation. Through big data, AI, IoT, and cloud computing, companies are transforming competition and efficiency. While existing research explores digital ecosystem shifts at the industry level, there is limited analysis on how individual firms implement digital transformation to enhance performance through business model innovation (Rong et al., 2023). Tesla exemplifies this shift, leveraging smart connectivity, OTA updates, and a direct-to-consumer sales model. Yet, the mechanisms linking digital transformation, business model innovation, and firm performance remain underexplored.

A key challenge lies in assessing the true impact of digital transformation on firm performance. Some studies suggest it yields direct benefits such as greater efficiency, reduced costs, and enhanced responsiveness. Others propose indirect gains via business model innovation (Van Tonder et al., 2023). For example, Tesla's autonomous driving and energy solutions may not be profitable in isolation but can generate returns through subscription-based models. Clarifying whether transformation in innovation, manufacturing, and marketing leads to direct performance gains or operates through business model shifts is vital. The outcome influences how firms design digital strategies and how stakeholders assess their feasibility.

Despite its promise, digital transformation brings risks. Security concerns, organizational resistance, and regulatory uncertainties are significant. Stewart (2022) notes that smart connectivity and automation, while boosting competitiveness, introduce cybersecurity threats, data breaches, and software vulnerabilities. Tesla's direct sales model, though effective, faces legal hurdles and regional adaptation challenges. Balancing short-term transformation gains with long-term sustainability and risk management is therefore crucial. This study investigates how digital transformation in product innovation, manufacturing, and marketing shapes business models and influences firm performance, using Tesla as a case. It explores both direct and indirect effects of digital initiatives and provides insights into how firms can leverage digitalization strategically. The research aims to bridge the gap between theory and practice, offering guidance for business leaders and contributing to ongoing academic discourse on digital transformation.

Significance of Study

Digital transformation is a pivotal driver of business model innovation and firm performance. While previous studies have explored facets of digitalization, few have systematically analyzed how product innovation, digital manufacturing, and marketing transformation interact to influence firm outcomes. Ghinoi and Di Toma (2021) emphasized the need for business model innovation in adapting to digital change but focused more on industry-level trends than firm-level execution. Additionally, much of the existing literature prioritizes financial metrics, overlooking the perspectives of internal stakeholders. This study addresses these gaps by collecting firsthand insights from industry professionals to better understand the practical impacts of digital transformation.

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Strategically, embedding digital capabilities into business models is now essential for sustaining competitive advantage. As Holtström (2021) noted, successful digital transformation requires the alignment of innovation with strategic intent. By drawing on empirical data, this study highlights how digital platforms reshape organizational operations and drive performance. It also identifies key enablers and barriers to digital transformation, enriching the theoretical link between digital strategy and business outcomes. outcomes.

Practically, the findings offer actionable insights for firms navigating digitalization, especially in the automotive and manufacturing sectors. Tesla exemplifies the benefits of digital business model innovation through direct-to-consumer sales, AI-powered automation, and SaaS-like recurring revenue streams (Van Tonder et al., 2023). However, effectiveness varies with firm size, digital maturity, and organizational culture. As Xiao et al. (2021) suggest, business model innovation bridges strategic flexibility and performance. This study deepens that understanding and provides guidance for firms, investors, and policymakers pursuing long-term digital growth.

Limitations of the Study

This study uses Tesla as a case to examine digital transformation within the automotive industry, but the findings may not be universally applicable. Digital transformation strategies and outcomes vary significantly across industries, with factors such as technology maturity, market structure, and the extent of data-driven business models playing crucial roles. Dash et al. (2023) found that a company's investment in and competency with technologies like IoT directly influence performance outcomes. Industries with high reliance on AI and automation may experience quicker digitalization benefits, while traditional sectors, like manufacturing, may face greater challenges in implementing such changes. Therefore, the results of this study may not apply to industries less dependent on software and AI technologies.

Additionally, the research primarily focuses on digital transformation through the lens of business model innovation and firm performance, neglecting the external factors that influence these outcomes. Cooke (2021) highlighted that regulatory policies, competition, and consumer behaviour also play vital roles in shaping digital strategies. This study's firm-level focus means it may not fully capture these macroeconomic and industry-wide influences. Future research could incorporate these broader factors for a more comprehensive understanding of digital transformation across various sectors.

Theoretical Foundation of Dynamic Capabilities View (DCV)

Dynamic Capabilities View (DCV) suggests that firms can maintain a competitive advantage by continuously sensing opportunities, seizing resources, and transforming their business models. The Sensing-Seizing-Transforming framework introduced by Teece et al. has been widely applied in strategic management to explain how firms adapt to market uncertainties by dynamically reconfiguring their resources. With the rise of digital transformation, the relevance of DCV has intensified, particularly in technology-driven industries where firms must integrate data-driven decision-making and service-based business models to remain competitive. However, while DCV effectively explains how firms develop internal capabilities, it does not wholly explain how consumers adopt and respond to digital business models. To bridge this gap, this research integrates the Technology Acceptance Model (TAM), which provides a consumer behavior framework for Digital-Driven Customer Engagement. Tesla exemplifies this model with its application of networked technology, driverless cars, smart manufacturing, and a direct-to-consumer (DTC) strategy for transforming the traditional automobile industry and establishing a sustainable competitive advantage.

In the sensing process, organizations must apply big data, AI, and IoT for detecting new opportunities and trends within the marketplace. According to Feroz & Kwak (2024), digital transformation competitive advantage for organizations depends on how effectively they capture and analyze data. AI-driven predictive analytics and data collection at scale for Tesla facilitate forecasting customer needs and product innovation optimization. For example, its OTA software updates continuously optimize vehicle performance with no hardware alteration, increasing user satisfaction and brand loyalty. From a TAM perspective, consumer adoption for Tesla's digital services depends on perceived ease and perceived usefulness. Tesla optimizes its e-commerce, remote test drive, and AI-driven customer service for facilitating consumer adoption for its digital marketing and service innovations.

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In the seizing phase, businesses must convert recognized opportunities into actual competitive advantages through new business models. Han et al. (2024) found that strategic agility is crucial for digital transformation, particularly for high-tech industries. Tesla's DTC sales model bypasses dealership networks, enhancing cost-effectiveness, brand control, and direct customer interactions. TAM, however, suggests that consumer adoption of DTC sales is based on trust, convenience, and brand engagement. Tesla establishes consumer confidence through transparent pricing, direct ordering through websites, and AI-driven customer service, enhancing acceptance for its digital-first sales model. Furthermore, Tesla introduced the Full Self-Driving (FSD) subscription model, transitioning from one-time payment to subscription-based revenue, emulating the Software-as-a-Service (SaaS) model. From a TAM perspective, this creates customer retention through continuous delivery of software updates improving functionality, ensuring long-term engagement and subscription duration.

In the adaptive phase, business models have to continuously adapt themselves based on fluctuating marketplace dynamics and customer requirements. Pang et al. (2025) stressed that long-term survival for companies depends on their ability for adaptive restructuring of resources and dynamic changes in business strategies. Tesla has evolved from a traditional automaker into a technology firm, spanning electric vehicles, autonomous cars, energy storage, charging networks, and AI products. Diversification works best for Tesla with optimal growth potential and least reliance on a single source of revenue.

Transformation, from a digital marketing perspective, also involves enhancing customer relationship management (CRM) and data-driven service customization. According to TAM, consumer loyalty and long-term engagement with digital services depend on their value addition perception. Tesla accomplishes this through AI-based CRM tools, predictive maintenance analytics, and real-time software updates, ensuring long-term customer engagement and satisfaction. Tongtong & Xinhang (2022) found that big data analytics enhance the ambidextrous innovation capability of companies, enabling a balance between exploratory innovation (new technology development) and exploitative innovation (optimization of existing capacity). Tesla's OTA upgrade system is a prime example, enabling cars to grow more functional over time without physical changes, thus enhancing customer retention and long-term satisfaction.

Rooted in the Sensing-Seizing-Transforming framework, this research develops a theoretical model (Figure 1) to analyze digital transformation's impact on firm performance through dimensions of Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement. While DCV theorizes how firms adapt their resources dynamically to facilitate transformation, it does not entirely capture how consumers interface with such digital innovations. TAM bridges this gap through providing a theoretical foundation for consumer adoption of digital business models, such as DTC sales, subscription models, and AI-driven customer interactions.

By coupling DCV (restructuring of strategic resources) with TAM (consumer adoption of digital innovation), this research offers a comprehensive framework for explaining how digital transformation generates firm performance. The integrated framework provides a clearer insight into digitalization's role in competitive advantage, with theoretical propositions for potential future research and strategic implications for organizations that undertake digital transformation.

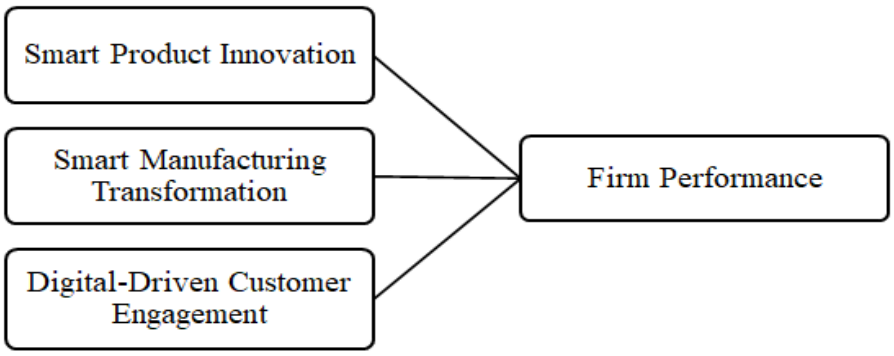

Figure 1: Theoretical Framework

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Firm Performance

Firm performance remains the central metric for evaluating a company's ability to compete, grow, and sustain itself over time. It is typically assessed through two key dimensions: economic performance (such as revenue growth, profitability, and market share) and non-economic performance (such as brand equity, innovation capability, customer satisfaction, and operational efficiency). While traditional financial metrics remain relevant, the rise of the digital economy has made non-financial indicators increasingly essential.

In today's dynamic business environment, especially within technology-intensive sectors like electric vehicle manufacturing, firm performance is no longer driven solely by financial outcomes. Companies must now measure how well they leverage digital tools, adapt to market shifts, and innovate continuously. The ability to integrate digital architecture, build agility, and develop customer-centric innovations has become a hallmark of sustained performance.

As Ahmed et al. (2024) argue, firm performance in the digital age is closely linked to Industry 4.0 capabilities, such as big data analytics, intelligent automation, and digitally enabled supply chains. While such investments may not immediately impact profits, they contribute significantly to long-term competitiveness and market responsiveness.

This study adopts a dual-dimensional approach to performance in balancing financial outcomes with non-financial indicators to better understand how digital transformation and business model innovation shape firm success. Ultimately, firm performance must be redefined not only as a measure of short-term profitability, but also as an indicator of future readiness, strategic agility, and digital maturity in a rapidly evolving marketplace.

Firm performance is typically assessed through two dimensions: financial and non-financial performance. Financial performance evaluates a firm's profitability and market standing using metrics such as revenue growth, profit margins, market share, and shareholder returns. Non-financial performance includes brand value, customer satisfaction, operational efficiency, and innovation capability. In the digital era, while financial metrics remain important, technological integration, customer experience, and sustainability have made non-financial indicators essential for evaluating long-term business success. A comprehensive performance assessment requires both dimensions to capture the full impact of digital transformation.

Financial performance reflects a company's ability to generate profits and sustain market competitiveness. Xiang (2022) found that investor sentiment and R&D investments, particularly in high-tech industries like electric vehicles, positively influence firm valuation. For Tesla, innovations in autonomous driving, battery systems, and smart manufacturing have enhanced both product uniqueness and financial performance. Additionally, CSR initiatives improve profitability by strengthening brand trust and attracting eco-conscious customers (Jain et al., 2022). Non-financial performance has become increasingly critical in driving sustainable growth. Duke et al. (2022) demonstrated that digital capabilities like AI, big data analytics, and connected technologies enhance operational effectiveness and customer loyalty. Tesla's DTC model and digitally driven user experiences exemplify how innovation contributes to brand strength and retention.

Governance also shapes non-financial outcomes. Junus et al. (2022) emphasized that board independence and strategic governance improve digital transformation success. Therefore, a balanced approach integrates financial and non-financial indicators is vital for measuring firm performance in the digital economy. It captures profitability, agility, and long-term adaptability.

Impact of Digital Transformation on Firm Performance

Digital transformation has emerged as a key driver of firm performance by reshaping product innovation, manufacturing processes, marketing strategies, and customer service. Unlike traditional competitive advantages based on economies of scale or cost control, digital technologies offer new pathways for enhancing financial outcomes, brand value, and long-term competitiveness through smart automation, data-driven decision-making, and superior user experiences.

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Tesla's approach illustrates the transformative potential of digital innovation. Subscription-based models like Full Self-Driving (FSD) software and Over-the-Air (OTA) updates generate recurring revenue and extend product life cycles, strengthening brand positioning while reducing early obsolescence. These innovations enable performance upgrades without physical modifications, fostering continuous product enhancement and customer retention.

In manufacturing, Tesla's use of AI-driven smart systems and real-time data analytics enhances production efficiency, reduces waste, and improves quality. Digital manufacturing also supports supply chain transparency and inventory optimization, reducing cost and increasing agility in uncertain market environments. Digital transformation also revolutionizes marketing and customer engagement. Tesla's Direct-to-Consumer (DTC) model eliminates intermediaries, reduces costs, and enhances control over branding and customer relationships. Real-time feedback, predictive maintenance, and intelligent recall systems boost customer satisfaction while minimizing service costs.

Overall, digital transformation enables firms to diversify revenue, optimize operations, and innovate in customer engagement. For firms embracing this shift, the benefits extend beyond profitability—impacting customer experience, brand loyalty, and market agility. As technologies like AI, big data, and cloud computing evolve, digital transformation will remain central to achieving sustainable competitive advantage and future-ready business performance.

Smart Product Innovation, Smart Manufacturing Transformation, Digital-Driven Customer Engagement

With the rapid development of digital technologies, Autonomous Driving and Connected Cars are reshaping competition in the automotive industry. Connected vehicles collect real-time data, enable remote monitoring, and receive Over-the-Air (OTA) software updates, transforming cars into continuously upgrading smart terminals. Simultaneously, autonomous driving integrates AI into vehicle control, path planning, and safety systems, enhancing intelligence and functionality. These innovations not only improve user experience but also redefine business models and create new revenue opportunities. As a digital transformation pioneer, Tesla leverages these technologies to drive competitiveness and build sustainable revenue streams.

The core advantage of connected cars is the ability to deliver an evolving, personalized user experience. León et al. (2024) emphasize the role of big data in corporate innovation, with Tesla using real-time analytics for feature optimization and tailored services. OTA updates enhance vehicle functions without hardware changes, boosting customer satisfaction. Onaji et al. (2022) noted that Digital Twin technology supports predictive maintenance and remote diagnostics, reducing after-sales costs and increasing customer loyalty.

Beyond experience, connected technology enables new revenue models. Tesla's subscription-based Full Self-Driving (FSD) software applies AI-powered dynamic pricing (Chen et al., 2024), generating long-term income beyond initial sales. Data monetization offers services like vehicle health reports and fleet management, adding value for insurers and regulators. Tesla also uses data and Digital Twin simulations to improve autonomous driving algorithms (Sharma & Kumar Tiwari, 2022). Yaşar et al. (2024) highlighted how real-time analytics fuel service innovation, enhancing adaptability and competitiveness. Ultimately, smart product innovation redefines vehicles as platforms in enhancing deployment, utilization, and profitability in a data-driven, software-defined future. Thus, this research formulates the following hypothesis:

H1: Smart Product Innovation positively impacts firm performance.

As global production accelerates toward intelligence and digitalization, improving efficiency, cutting costs, and increasing market responsiveness have become strategic priorities. Smart manufacturing emphasizes automation, real-time analytics, and intelligent systems, while supply chain digitalization applies technologies like cloud computing, blockchain, and AI to optimize logistics and inventory. Tesla exemplifies these trends, creating a responsive, efficient, and sustainable production system that strengthens its market competitiveness.

Smart manufacturing minimizes human error and enhances production through automation and intelligent integration. Hottenrott et al. (2022) found that such systems reduce waste and improve efficiency. Tesla's

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Gigafactory integrates robotic assembly, AI monitoring, and real-time production analytics. To overcome Industry 4.0 challenges such as system coordination and data integration, Tesla employs Industrial Internet of Things (IIoT) and AI-based visual inspection systems to adjust production dynamically and maintain high product quality (Bagherian et al., 2020).

Tesla also applies Lean Manufacturing and Six Sigma methodologies to minimize waste and enhance operational stability. Ozkan-Ozen et al. (2024) note that data-driven approaches in RAMI 4.0 enhance process consistency. Tesla's use of predictive analytics enables bottleneck detection and predictive maintenance, avoiding downtime and ensuring stable production. Beyond manufacturing, Tesla's digitalized supply chain enhances resilience and responsiveness. Rai et al. (2021) emphasized AI and blockchain for transparency and inventory optimization. Tesla uses AI for dynamic demand forecasting and blockchain for end-to-end material traceability (Ferri & Takahashi, 2024). Together, Tesla's smart manufacturing and digital supply chain strategies drive cost efficiency, speed, and innovation to secure a long-term edge in the competitive EV industry. Therefore, this research begins with the following hypothesis:

H2: Smart Manufacturing Transformation positively impacts firm performance.

Digital technology has transformed service and marketing models, enabling Tesla to build a highly data-driven customer engagement ecosystem. Through online direct sales, remote software updates, and intelligent optimization, Tesla enhances user experience, improves customer loyalty, and reduces costs typically associated with traditional dealership and maintenance models.

A core of Tesla's strategy is its Direct-to-Consumer (DTC) model. Krüger et al. (2025) explored how direct digital channels, like metaverse spaces, give brands control over customer experiences mirrored in Tesla's online and in-store sales without dealerships. This eliminates intermediary costs and provides data for refined marketing and CRM. Hollebeek et al. (2022) emphasized CRM's role in customer-focused business model innovation. Tesla integrates CRM tools in its app, enabling personalized services, support, and marketing.

Over-the-Air (OTA) updates play a transformative role in Tesla's digital service. Zhao & Liu (2025) described AI-driven innovation in operational processes and customer experience. OTA enables Tesla to deliver new features and fixes remotely, such as addressing braking issues without physical recalls in reducing service costs and enhancing satisfaction. Tesla's FSD subscription model further generates long-term revenue (Motjolopane & Ruhode, 2021).

Tesla's Intelligent Recall & Optimization uses big data and AI to predict failures and improve vehicle safety. Österle et al. (2024) linked smart service experience to brand loyalty. Tesla uses real-time fleet data to improve Autopilot and provide personalized safety recommendations (Zhao & Liu, 2025). Tesla's digital approach streamlines operations, enhances engagement, and creates new revenue streams by offering a competitive edge in the software-defined automotive era. Therefore, this research proposes the following hypothesis:

H3: Digital-Driven Customer Engagement positively impacts firm performance.

RESEARCH METHODOLOGY

This study adopts a quantitative research design using a structured survey questionnaire to investigate the impact of digital transformation (DT) on firm performance (FP). As companies increasingly embrace digital technologies, they undergo substantial changes across product innovation, manufacturing processes, and customer engagement models. While digital transformation is widely recognized as a strategic tool for enhancing competitiveness, understanding how its various dimensions influence firm performance remains a crucial area of exploration for both scholars and practitioners.

Grounded in the findings of Ahmed et al. (2024), who demonstrated that digital transformation strategies influence not only operational efficiency but also market competitiveness and long-term growth, this study focuses on three core dimensions of DT which are Smart Product Innovation, Smart Manufacturing Transformation, Digital-Driven Customer Engagement.

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The study examines how these dimensions affect both financial performance (such as revenue growth, profitability, market share) and non-financial performance (such as brand value, customer satisfaction, and operational efficiency). Data collection is conducted through a structured questionnaire distributed to firms across relevant sectors. The survey captures digital transformation practices, managerial perceptions, and indicators of firm performance. Variables are measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) to ensure objectivity and reliability.

Data analysis was performed using SPSS Version 26 to conduct descriptive statistics followed by correlation analysis to identify relationships between DT dimensions and firm performance. Subsequently, multiple regression analysis was employed to test causal effects and validate the proposed research model. This research is anchored in the Dynamic Capabilities View (DCV), which posits that firms sustain competitive advantage in volatile markets through their abilities to sense, seize, and transform (Teece, 2007). In the digital era, dynamic capabilities rather than static resources are essential for navigating technological change. As highlighted by Ahmed et al. (2024), the effectiveness of digital transformation depends not only on technology adoption but also on the firm's ability to reconfigure its capabilities in response to emerging opportunities. By quantitatively assessing these relationships, this study aims to contribute to both academic literature and managerial practice in the domain of digital strategy and performance optimization.

Sampling Technique

This study focuses on Tesla's operations in the China market as the primary research context, selecting a diverse group of respondents to examine the impact of digital transformation on firm performance. The key respondent categories include managerial personnel at Tesla's Shanghai Gigafactory, current and potential customers of Tesla in China, and industry experts and commentators from major automotive platforms such as Autohome and Dongchedi.

By adopting a diversified sampling strategy, the research aims to provide a comprehensive perspective on how digital transformation particularly in the dimensions of Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement influences both internal operations and external market performance. A total of 300 questionnaires were distributed and strategically allocated across the three respondent groups inclusive of automotive industry managers (including production, supply chain, marketing, and after-sales personnel), automotive consumers, and industry analysts and media commentators.

Data collection was conducted entirely online, with the questionnaire distributed via Google Forms and Wenjuanxing, and shared across social media, automotive forums, and Tesla owner communities. Specific platforms include WeChat groups, Weibo, Zhihu, Autohome, and Dongchedi, ensuring a diverse and representative sample. Management personnel at Tesla's Shanghai Gigafactory, a core group in this study, provide firsthand insights into Smart Product Innovation, smart manufacturing, and marketing digitalization, while Tesla customers and industry experts contribute perspectives on user experience and market performance, allowing for a comprehensive assessment of the impact of digital transformation on firm performance.

This mixed-sample approach ensures a broad and representative dataset, capturing both business-side insights and consumer perspectives. As a global leader in electric vehicles, Tesla's China operations offer a rich setting for this investigation. The Shanghai Gigafactory exemplifies cutting-edge smart manufacturing, integrating AI, IoT, data analytics, and automated production to drive cost reduction and operational efficiency. In parallel, Tesla's Direct-to-Consumer (DTC) sales model and Over-the-Air (OTA) software update strategy illustrate how digitalization improves customer engagement and firm agility.

Tesla employees offer firsthand insights into how digital innovation supports operational decision-making, strategic agility, and process efficiency. Meanwhile, customers and potential buyers offer critical evaluations of how these digital initiatives influence user experience, brand loyalty, and purchase behaviour. Finally, industry analysts and journalists contribute to data triangulation by offering an external lens on Tesla's competitive position and market perception. Following the approach of Junus et al. (2022) who used a multi-source survey strategy to link corporate governance with firm performance. This study ensures greater

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credibility, contextual relevance, and robustness of findings. This integrated, multi-stakeholder design supports a holistic evaluation of Tesla's digital transformation practices in China and enriches the understanding of how digital innovation influences firm performance across strategic, operational, and customer-centric domains.

Pilot Test

The questionnaire was further piloted before it was administered in full to assess its validity and reliability. This pilot test included a sample representing 10% of the anticipated sample size. The purpose of the pilot test was to evaluate the clarity, comprehension, and overall design of the questionnaire. Additionally, the reliability of the questionnaire was analyzed using Cronbach's Alpha, a widely used method to assess the internal consistency of a scale. Both the independent variables (IV) and dependent variables (DV) demonstrated Cronbach's Alpha values greater than 0.7, indicating satisfactory reliability of the measurement instrument for the pilot test data. Based on the feedback from the pilot test, some ambiguous questions were revised, and the entire questionnaire was refined for greater precision.

Table 1: Cronbach's Alpha for Pilot Test Results

Variable	Cronbach's Alpha
Smart Product Innovation	0.85
Smart Manufacturing Transformation	0.82
Digital-Driven Customer Engagement	0.88
Financial Performance	0.91
Non-Financial Performance	0.87

FINDINGS AND DISCUSSIONS

The results from the descriptive statistical analysis provide foundational support for the subsequent correlation analysis and regression analysis. Below are the statistical results for smart product innovation, smart manufacturing transformation, digital-driven customer engagement and firm performance (financial performance and non-financial performance), revealing how these variables perform within the sample.

Table 2: Descriptive Statistics of Smart Product Innovation

Items	Mean	SD
1. Connected technology enhances vehicle value	4.20	0.85
2. Autonomous driving increases brand trust	4.22	0.79
3. Remote software updates enhance user experience	4.15	0.87
4. Autonomous driving is a key factor in choosing electric vehicles	4.18	0.83
5. I am willing to pay extra for more advanced digital features	4.25	0.75

Smart Product Innovation is highly recognized among respondents, especially in terms of enhancing brand trust and user experience (Table 2). While there is some divergence in opinions on specific technologies (such as remote updates), the willingness to pay for digital features is high, suggesting strong consumer trust and acceptance of technological innovations in brands like Tesla.

Table 3: Descriptive Statistics of Smart Manufacturing Transformation

Items	Mean	SD
1. Smart manufacturing reduces production costs	4.13	0.79
2. Big data and IoT improve production efficiency	4.17	0.80
3. Digital supply chain management improves product quality	4.11	0.84
4. Smart manufacturing shortens production cycles	4.08	0.78
5. Digital supply chain management improves delivery accuracy	4.12	0.76

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At the same scenario, smart manufacturing transformation has a significant positive impact on improving production efficiency, reducing costs, enhancing product quality, and ensuring accurate deliveries (Table 3). While some items show larger standard deviations, indicating variation in implementation across different companies, the overall trend demonstrates the substantial role that smart manufacturing plays in enhancing operational performance.

Table 4: Descriptive Statistics of Digital-Driven Customer Engagement

Items	Mean	SD
1. DTC sales are more efficient than traditional sales	4.13	0.79
2. Remote software updates enhance long-term value	4.17	0.80
3. AI-driven customer service improves purchasing experience	4.11	0.84
4. Smart recall system is more reliable than traditional recalls	4.08	0.78
5. Digital marketing increases trust in the brand	4.12	0.76

Also, Digital-Driven Customer Engagement plays a significant role in enhancing brand trust and improving customer experience, especially through DTC sales, AI-driven customer service, and remote updates (Table 4).

Table 5: Descriptive Statistics of Financial Performance

Items	Mean	SD
1. Digital transformation enhances market share and brand influence	4.20	0.81
2. Digital innovation improves profitability	4.18	0.79
3. Subscription models create stable revenue streams for the company	4.22	0.77
4. Digital marketing enhances market competitiveness	4.15	0.82
5. Consumers prefer digital-first brands, driving revenue growth	4.14	0.80

Table 5 shows that the Financial Performance indicators show that digital transformation positively impacts financial outcomes, particularly in terms of market share, profitability, and revenue diversification. Meanwhile, Non-Financial Performance is significantly enhanced by digital transformation, especially in areas such as customer loyalty, innovation capabilities, and operational efficiency, with widespread recognition of the positive impact of digitalization (Table 6).

Table 6: Descriptive Statistics of Non-Financial Performance

Items	Mean	SD
1. Digital services enhance customer loyalty	4.16	0.80
2. Digital transformation increases innovation capabilities	4.20	0.78
3. AI-driven customer service improves customer satisfaction	4.11	0.79
4. Digital supply chain management enhances operational efficiency	4.14	0.82
5. Digital transformation enhances the company's competitive advantage	4.13	0.80

Correlation Analysis

To examine the relationships between Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement and Firm Performance, this study employed Pearson correlation coefficients, assessing the linear correlations between the variables. The results of the correlation analysis help us understand the relationships between different dimensions of digital transformation (Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement) and firm

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performance (both Financial Performance and Non-Financial Performance), providing a foundation for the subsequent regression analysis.

Table 7: Pearson Correlation Analysis

Variables	1	2	3	4	5
1. Financial Performance	----	0.56**	0.48**	0.51**	0.47**
2. Non-Financial Performance	0.56**	----	0.53**	0.49**	0.52**
3. Smart Product Innovation	0.48**	0.53**	----	0.67**	0.55**
4. Smart Manufacturing Transformation	0.51**	0.49**	0.67**	----	0.61**
5. Digital-Driven Customer Engagement	0.47**	0.52**	0.55**	0.61**	----

Note: Correlation is significant at the 0.01 level (two-tailed)

Table 7 presents the results of the Pearson correlation analysis. All independent variables show a positive and significant correlation with the dependent variables (p-values less than 0.01). Below are some key findings:

i. The correlation coefficient between Financial Performance and Non-Financial Performance is 0.56, indicating a moderate-to-strong positive relationship between the two, suggesting that improving non-financial performance also positively influences financial performance.

ii. Smart Product Innovation shows a correlation of 0.48 with Financial Performance and 0.53 with Non-Financial Performance, indicating that smart product innovation has a positive impact on both financial and non-financial performance.

iii. Smart Manufacturing Transformation has a correlation of 0.51 with Financial Performance and 0.49 with Non-Financial Performance, showing that smart manufacturing plays a significant role in improving both financial and non-financial performance.

iv. Digital-Driven Customer Engagement shows a correlation of 0.47 with Financial Performance and 0.52 with Non-Financial Performance, indicating that digital customer engagement (such as DTC sales, AI-driven customer service, and so forth.) has a positive influence on enhancing both types of firm performance.

These correlation results suggest that the various dimensions of digital transformation (such as Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement) have a positive impact on both financial and non-financial performance, which lays a solid foundation for the regression analysis.

Regression Analysis

Regression analysis is employed here for further analysis of the impact of different dimensions of digital transformation on firm performance. With multiple regression analysis, we can quantify the impact of Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement (independent variables - IVs) on Financial Performance and Non-Financial Performance (dependent variables - DVs). Regression results will help us analyze predictive value of these variables on firm performance and whether research hypotheses (H1, H2, H3) hold.

To further analyze the strong influence of digital transformation on firm performance, a multiple regression analysis (MRA) model is applied to the data with Financial Performance and Non-Financial Performance serving as dependent variables (DVs), and Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement serving as independent variables (IVs). This regression model aims to assess the effects of independent variables on financial and non-financial performance and test if those different axes of digital transformation have a statistically significant effect on firm performance improvement. Knowledge of the dimensions for digital transformation helps to understand how DIT can affect profitability, market performance, and customer relations within the operational activities of the companies.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue V May 2025

Table 8: Multiple Regression Analysis

Independent Variables	Financial Performance	Non-Financial Performance
Smart Product Innovation	β = 0.32**	β = 0.30**
Smart Manufacturing Transformation	β = 0.28**	β = 0.27**
Digital-Driven Customer Engagement	β = 0.25**	β = 0.29**
R^2	0.41	0.44
Adjusted R^2	0.39	0.42
F-value	25.34**	28.56**

Note: Regression coefficients are significant at the 0.01 level (two-tailed)

Regression results reveal that Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement all have a positive influence on financial as well as non-financial performance:

i. Smart Product Innovation has a regression coefficient of β = 0.32 for Financial Performance and β = 0.30 for Non-Financial Performance, indicating that smart product innovation has a substantial positive impact on both financial and non-financial performance.

ii. Smart Manufacturing Transformation has a regression coefficient of β = 0.28 for Financial Performance and β = 0.27 for Non-Financial Performance, suggesting that smart manufacturing transformation positively impacts both financial and non-financial outcomes, such as customer satisfaction and brand value.

iii. Digital-Driven Customer Engagement has a regression coefficient of β = 0.25 for Financial Performance and β = 0.29 for Non-Financial Performance, indicating that digital customer engagement (such as DTC sales, AI-driven customer service, and so on.) plays a significant role in improving firm performance.

Additionally, the R^2 values are 0.41 for financial performance and 0.44 for non-financial performance, indicating that the regression model explains about 41% and 44% of the variance in financial and non-financial performance, respectively. The Adjusted R^2 further confirms the model's good fit. The F-values also suggest the overall significance of the model, indicating that all independent variables have a statistically significant impact on the dependent variables.

Interpretation of Results

The regression analysis results indicate that the dimensions of digital transformation have a significant positive impact on both financial performance and non-financial performance. Smart Product Innovation has a significant positive impact on both financial performance and non-financial performance. This aligns with H1 (Smart Product Innovation has a positive impact on firm performance), confirming that smart product innovations (such as autonomous driving, remote software updates, and connected technologies) directly enhance profitability, market share, brand value, and customer satisfaction.

Smart Manufacturing Transformation has a more significant impact on non-financial performance, reflecting its critical role in enhancing brand value and customer satisfaction. This supports H2 (Smart Manufacturing Transformation has a positive impact on firm performance). Specifically, smart manufacturing (e.g., automation, data analytics, digital supply chains) helps companies improve production efficiency, reduce costs, and enhance product quality, thereby positively impacting non-financial indicators. Although it also impacts financial performance, its primary effect is on non-financial performance, demonstrating that this transformation plays a more significant role in customer and brand-related factors.

Digital-Driven Customer Engagement has a significant positive impact on both financial performance and non-financial performance. This supports H3 (Digital-Driven Customer Engagement has a positive impact on firm performance). Particularly, DTC (direct sales), remote software updates (OTA), and AI-driven customer service significantly enhance customer satisfaction and loyalty, and in turn, improve the firm’s revenue and market share.

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue V May 2025

Hypothesis Testing Results

H1: Smart Product Innovation has a positive impact on firm performance

The regression results show that Smart Product Innovation significantly impacts both financial and non-financial performance with coefficients of $\beta = 0.32$ and $\beta = 0.30$, respectively. Therefore, H1 is supported.

H2: Smart Manufacturing Transformation has a positive impact on firm performance

The results show that Smart Manufacturing Transformation has a stronger impact on non-financial performance ($\beta = 0.27$) and a moderate impact on financial performance ($\beta = 0.28$). Thus, H2 is supported.

H3: Digital-Driven Customer Engagement has a positive impact on firm performance

The coefficients for Digital-Driven Customer Engagement are $\beta = 0.25$ (financial performance) and $\beta = 0.29$ (non-financial performance), indicating a significant positive effect on both performance outcomes. Hence, H3 is supported.

CONCLUSION

This study examined the impact of digital transformation on firm performance, focusing on three core dimensions including of Smart Product Innovation, Smart Manufacturing Transformation, and Digital-Driven Customer Engagement. Using survey data from 300 respondents and SPSS-based analyses, including descriptive statistics, correlation, and regression, the findings strongly support the proposed hypotheses. Technologies such as autonomous driving, remote updates, and connected vehicle systems significantly enhance firm performance, particularly in financial metrics and brand value. These innovations increase consumer trust, shape purchase decisions, and drive revenue growth and market share expansion. Smart manufacturing technologies, including automation, IoT, and data analytics, show a stronger influence on non-financial performance. Gains in efficiency, product quality, and responsiveness lead to higher customer satisfaction and a stronger brand reputation, reinforcing long-term competitiveness. Customer-focused digital strategies such as Tesla's DTC sales model, OTA updates, and AI-driven service positively affect both financial and non-financial performance. Enhanced customer experience, greater loyalty, and improved brand image translate into cost-effective operations and higher customer retention.

These results confirm that digital transformation, when implemented holistically, drives both short-term gains and sustainable competitive advantage. The findings provide empirical validation for firms, particularly in the automotive sector, to strategically invest in digital capabilities across products, processes, and customer touchpoints.

IMPLICATIONS OF THE STUDY

This study highlights the strategic value of digital transformation in driving both financial and non-financial performance. For managers, especially in the automotive sector, digital transformation must be embraced not as a trend, but as a core enabler of sustainable competitiveness. Smart Product Innovation and Digital-Driven Customer Engagement emerged as key contributors to growth. Firms should prioritize investment in advanced product features such as autonomous driving, IoT connectivity, and remote software updates to enhance product value and brand perception. Likewise, digital engagement strategies including DTC sales, AI-powered support, and OTA updates significantly improve customer satisfaction and loyalty. These approaches build lasting customer relationships and strengthen brand resilience in competitive markets. Smart manufacturing technologies contribute to operational efficiency, product quality, and cost control. Beyond internal gains, they also impact the customer experience by aligning production with real-time demand and expectations. Adaptive, tech-enabled operations help firms deliver higher quality and customized offerings, supporting long-term loyalty and competitive differentiation.

Future-focused organizations should also integrate emerging technologies such as AI, big data, and blockchain into their transformation strategies. These tools enhance innovation capacity, agility, and decision-making

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue V May 2025

effectiveness. A proactive digital mindset ensures firms remain responsive to market change, seize new opportunities, and maintain strategic relevance in a fast-evolving business environment.

RECOMMENDATIONS FOR FUTURE RESEARCH

This study offers valuable insights into how digital transformation (DT) influences firm performance; however, several avenues remain open for further exploration. Firstly, future research could expand the industry scope beyond the automotive sector. Investigating DT in sectors such as retail, finance, or manufacturing could provide a broader understanding of how digital strategies function across varying operational contexts. Similarly, comparative cross-country studies, especially between developed and developing nations could reveal how cultural, economic, and policy differences shape digital transformation and its outcomes.

Secondly, firm size should be considered more deeply. While this study focused on a large corporation, small and medium-sized enterprises (SMEs) often face unique challenges due to limited resources. Future studies should explore how SMEs adopt digital transformation, manage constraints, and develop innovation strategies compared to large firms.

Thirdly, as emerging technologies evolve rapidly, future research could delve into the roles of artificial intelligence, big data, blockchain, and IoT in enhancing business performance. Investigating how these technologies contribute to customer experience, efficiency, and innovation would provide forward-looking insights.

Finally, integrating different theoretical frameworks, such as the Resource-Based View (RBV) or Technology-Organization-Environment (TOE), alongside the Dynamic Capabilities View (DCV), could enrich the analysis by offering diverse lenses to examine digital transformation. In sum, future studies should explore digital transformation across multiple dimensions such as industry, geography, firm size, and technology to provide more comprehensive and practical guidance for both researchers and practitioners.

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