ARTIFICIAL INTELLIGENCE AND DIGITAL TRANSFORMATION AS DRIVERS OF CORPORATE INNOVATION IN THE GLOBAL AUTOMOTIVE INDUSTRY

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Abstract

This study investigates how AI-driven digital transformation shapes innovation performance in the global automotive industry. As the sector undergoes rapid technological disruption, the research examines how different dimensions of digital transformation—AI applications, depth, and breadth of digital integration—influence firms' innovation capabilities and outcomes. Using Innovation Performance as the dependent variable, the study assesses how effectively digital initiatives generate competitive advantages. It further introduces Digital Capabilities as a mediating variable, arguing that stronger digital resources enhance the impact of AI and digital transformation on innovation. Firm Size functions as a moderating variable, evaluating how organizational scale shapes these effects. To control for external influences, factors such as Industry Type, Market Competition, Regulatory Policies, and Technological Progress are included. The findings contribute to understanding how AI and digitalization jointly transform innovation mechanisms in automotive enterprises, offering empirical insights and strategic implications for enhancing corporate competitiveness in a technology-driven era.

Keywords: AI-Driven Digital Transformation, Digital Innovation Strategies, Industry 4.0 in Automotive

Introduction

The global automotive industry is undergoing a transformative shift driven by the integration of artificial intelligence (AI) and digital technologies. This evolution is not merely technological it reshapes the way automotive enterprises innovate, operate, and deliver value in an increasingly dynamic and competitive market. Grounded in well-established theoretical frameworks such as the Resource-Based View (RBV), Knowledge-Based View (KBV), Dynamic Capabilities Theory, Institutional Theory, Diffusion of Innovations, the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Schumpeter's Theory of Innovation, and Drucker's Perspective on Innovation, this study examines the multifaceted impact of AI applications and digital transformation on corporate innovation performance (CIP) within global automotive firms.

The ongoing transformation of the automotive sector is marked by advancements in autonomous systems, connected technologies, and smart manufacturing, fueled by the strategic implementation of AI. These developments extend beyond product design and production efficiency, influencing customer experience, supply chain agility, and business model innovation. Companies like Tesla, BMW, and other early adopters serve as paradigms of how AI and digital strategies redefine competitive advantage through intelligent systems and data-driven innovation.

However, the successful adoption of AI and digital transformation is not without challenges. Issues such as data privacy, workforce reskilling, ethical implications, and regulatory compliance remain critical obstacles that enterprises must navigate. Theoretical

perspectives like Institutional Theory provide insight into how external forces, including policy and regulation, influence the pace and nature of AI adoption. At the same time, models such as TAM and UTAUT highlight the significance of user acceptance and perceived value in determining technological integration success.

This study focuses on three primary dimensions: AI applications (AIA), the depth and breadth of digital transformation (DDT and BDT), and the mediating role of digital capabilities (DC) in driving innovation. Furthermore, contextual variables such as firm size (FS), industry type (IT), market competition (MC), regulatory policy (RP), and technological progress (TP) are incorporated to provide a more comprehensive understanding of how automotive enterprises achieve innovation outcomes in different settings.

The core research questions explore the influence of AI on innovation performance, the role of digital capabilities as mediators, and how firm size moderates this relationship. The study also investigates how the depth and breadth of digital transformation efforts influence CIP and how external forces namely RP and TP further shape these relationships. By employing a mixed-methods approach combining quantitative modeling and qualitative insights from industry practitioners and policymakers, the study aims to uncover the strategic pathways automotive firms can adopt to effectively navigate the era of digital disruption.

The findings of this research are expected to offer both theoretical and practical contributions. Theoretically, the study bridges multiple conceptual lenses to explain how firms manage innovation in the face of technological complexity. Practically, it provides actionable recommendations for automotive firms seeking to leverage AI and digital transformation as strategic assets to enhance innovation performance, sustain competitive advantage, and respond to rapid environmental changes. This integrated framework serves not only as an academic contribution but also as a strategic guide for corporate leaders, innovation managers, and policymakers involved in shaping the future of the automotive industry.

Research Objective

1. To study the current state of AI applications, digital transformation, and innovation performance in global automotive enterprises.
   - Quantify the states of AI Applications (AIA), Depth of Digital Transformation (DDT), Breadth of Digital Transformation (BDT), and Corporate Innovation Performance (CIP) using descriptive statistics.
   - Provide a foundational understanding of these variables across different firm sizes (FS), industry types (IT), and market competition (MC) levels.
2. To analyze the effects of AI and digital transformation on innovation performance.
   - Examine the relationships between AIA, DDT, BDT, and CIP, considering the mediating role of Digital Capabilities (DC) and the moderating effects of Firm Size (FS), Industry Type (IT), and Market Competition (MC).
   - Incorporate the influence of external variables, such as Regulatory Policies (RP) and Technological Progress (TP).
   - Use statistical tools like regression analysis or structural equation modeling to test the hypotheses (H1–H9) and identify key trends.
3. To develop a strategic framework of recommendations for optimizing innovation performance in global automotive enterprises.
   - Conduct qualitative research (e.g., stakeholder interviews) to gain deeper insights into the quantitative findings from Objective 2.
   - Explore the role of AIA, DDT, BDT, and DC in influencing CIP under varying regulatory and technological conditions.

- Formulate a comprehensive framework of strategic recommendations that integrates insights on Regulatory Policies (RP) and Technological Progress (TP) to guide enterprises in optimizing their innovation performance.

Research Methodology

1. Research Methodology

This study employs a positivist research paradigm with a deductive approach, focusing on testing established theories on digital transformation, AI applications, and corporate innovation performance.

An explanatory sequential mixed-methods design is used:

- **Quantitative phase:** Cross-sectional survey of global automotive enterprises to examine relationships between AI Applications, Depth and Breadth of Digital Transformation, and Corporate Innovation Performance.
- **Qualitative phase:** Semi-structured interviews with industry experts to explain and contextualize quantitative results.

The integration of findings ensures a comprehensive understanding of the causal relationships and contextual factors.

2. Research Steps

2.1 Conduct literature review and develop research framework and hypotheses.

2.2 Design and pilot test the survey questionnaire.

2.3 Develop qualitative interview guide.

2.4 Implement stratified random sampling for the quantitative survey; purposive sampling for interviews.

2.5 Collect quantitative data (survey) and qualitative data (interviews).

2.6 Clean and prepare datasets.

2.7 Analyze quantitative data using SEM (PLS-SEM) and perform mediation/ moderation tests.

2.8 Conduct thematic analysis of qualitative data using NVivo.

2.9 Integrate quantitative and qualitative findings for interpretation.

3. Data Collection

- **Quantitative Data:** Structured survey targeting senior managers, CIOs, and innovation leaders in automotive enterprises worldwide. Measures include AI applications, depth and breadth of digital transformation, digital capabilities, firm size, and innovation performance, along with control variables (industry type, market competition).
- **Qualitative Data:** Semi-structured interviews with 15–20 industry experts, executives, and policymakers to gain insights into digital capabilities, firm size effects, and external factors (regulatory policies, technological progress).
- **Sampling:** Stratified random sampling for quantitative phase (target ~300 firms); purposive sampling for qualitative phase until data saturation.

4. Data Analysis

4.1 Quantitative:

- Descriptive statistics and correlation analysis.
- Multiple regression and PLS-SEM to test hypothesized relationships.
- Mediation analysis (digital capabilities) and moderation analysis (firm size).
- Robustness checks for model stability.

4.2 Qualitative:

- Thematic analysis in NVivo following inductive coding.
- Triangulation with quantitative results to enrich interpretation.

4.3 Integration: Interpret statistical relationships in light of qualitative themes, providing both generalizable and context-specific insights.

Research Results

1. **Summary of the Quantitative study**

The quantitative analysis provided robust statistical evidence to address the first two research objectives.

For O1: The descriptive statistics painted a picture of a dynamic industry where firms are actively investing in AIA and DT, operate in a highly competitive landscape, and perceive their CIP to be relatively high.

For O2: The SEM analysis confirmed the central theses of the study. AIA, DDT, and BDT all positively influence CIP. DC were shown to be a crucial partial mediator, acting as the mechanism through which technology investments are converted into innovation outcomes. Furthermore, FS was found to be a significant moderator, enhancing the positive effect of AIA on CIP for larger enterprises. The strongest individual driver of innovation was found to be DDT, underscoring the importance of strategic, systemic change over superficial adoption. These findings provide a solid empirical foundation that will be further explored and contextualized in the qualitative study.

2. **Summary of the qualitative study**

The qualitative study successfully addressed O3 by providing rich, contextual insights into how global automotive firms navigate their external environment. The thematic analysis revealed that innovation strategy is shaped by the "dual pressure" of regulation (RP) and technological pace (TP), leading to a strategic shift from innovating on the physical product to building digital ecosystems. The study also highlighted the critical, and often constraining, role of human factors—namely the "war for talent" and the challenge of cultural transformation. These findings are not just descriptive; they form the basis for the strategic recommendations that will be developed in Chapter 5. They provide the "why" behind the quantitative results, explaining what it truly means for a firm to develop DC in the face of intense external pressures.

3. **Summary Comparison of Quantitative and Qualitative Studies**

This section integrates the quantitative "what" with the qualitative "why/how" to provide a multi-layered understanding, fulfilling the mixed-methods purpose.

Convergence of Findings

- Digital Capabilities as Core Mediator – Quantitative analysis confirmed DC as the strongest mediator linking technology investment to CIP, with all indirect effects significant. Qualitative insights reinforced this, showing executives focus on building software, data analytics, and agile capabilities.

- Depth Over Breadth – DDT (β=0.25) had a stronger effect on CIP than BDT (β=0.11). Interviews highlighted that deep process integration in R&D and manufacturing drives true competitive advantage, while surface-level digitization adds little value.

- Competitive Pressure – MC significantly boosted CIP in the model, echoed in interviews via frequent references to rivals (e.g., Tesla) and intense market competition, especially in China.

Complementarity of Findings

- Firm Size Moderation Explained – Large firms benefit more from AIA due to resources like big datasets, specialized talent, and advanced infrastructure—advantages SMEs often lack.

- Contextualizing CIP – While quantitatively measured via a validated scale, qualitative data revealed it involves over-the-air updates, subscription services, and enhanced customer lifetime value, not just new models.
- Exogenous Variables Added – RP and TP, absent from the quantitative model, emerged in interviews as key forces shaping strategic context, forming the basis for the O3 strategic framework.

Conclusion

The quantitative study established the structural relationships between AIA, DT, and CIP. The qualitative study explained underlying mechanisms, operational challenges, and external influences. Together, they deliver a comprehensive, evidence-based foundation for the dissertation's discussion and conclusions.

Discussion

This study's findings align with prior research on AI, digital transformation (DT), and innovation, confirming Digital Capabilities (DC) as a critical mediator in linking technology investment to Corporate Innovation Performance (CIP). The stronger effect of Depth of Digital Transformation (DDT) over Breadth (BDT) supports theories of deep organizational change, suggesting that superficial digitization delivers limited long-term innovation.

Qualitative themes add contextual depth:

- Dual Pressure – Regulatory complexity (e.g., GDPR, UN R155) and rapid technological change disrupt traditional R&D cycles.
- Ecosystem Innovation – Shift toward platform-based models, similar to smartphone industry strategies.
- Human-in-the-Loop – Talent and organizational culture remain central to digital transformation success.

The moderating effect of Firm Size is explained by large firms' access to richer datasets, specialized talent, and infrastructure, enabling greater innovation impact from AI applications.

Two organizational learning factors emerged:

1. Continuous Learning Intention (CLI) – Sustained motivation and structured learning routines (e.g., digital bootcamps, cross-project rotations) enhance DC and amplify its mediating role, consistent with dynamic capabilities theory.
2. Learning Satisfaction (LSAT) – Positive employee experiences in learning programs increase tool adoption, knowledge sharing, and reduce resistance, strengthening the DC–CIP link through higher self-efficacy and engagement.

Limitations include the automotive-specific sample and reliance on self-reported data, which may affect generalizability. Nonetheless, results offer both theoretical contributions and actionable guidance for managers aiming to integrate AI and DT for sustainable innovation.

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