

A Case Study on Strategic Digital Transformation in Traditional Manufacturing

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Abstract

The present study conducts a longitudinal single-case analysis guided by Resource-Based Theory (RBT), Dynamic Capabilities, and Organizational Learning Theory to investigate the strategic digital transformation (DT) of a traditional Taiwanese manufacturing firm. The research examines how the phased integration of ERP systems, real-time data platforms, and AI-driven decision support tools has facilitated improvements in operational efficiency, managerial competencies, and environmental sustainability. A multi-source methodology was employed, comprising structured interviews, expert panel evaluations, and organizational performance metrics. This methodology was applied across three stages of transformation: digitization, optimization, and transformation. The findings indicate significant advancements in processing efficiency, profit margins, and the development of managerial aptitude. Additionally, the transition to electronic documentation has nearly eliminated the use of paper. The study further identifies organizational learning cycles and adaptive capabilities as key enablers in overcoming internal resistance and technological inertia. This work makes a notable contribution to the existing DT literature by integrating strategic capability-building frameworks with practical implementation insights. It provides a contextualized model for transformation in resource-constrained traditional industries.

Keywords: Strategic Digital Transformation, Resource-Based Theory, Managerial Competency Development, ERP and AI Integration, Traditional Manufacturing SMEs

1 Introduction

Taiwan's manufacturing industry occupies a critical position in the global supply chain, yet it faces increasing pressures from globalization, technological disruptions, and the rise of platform-based competition. Despite its industrial legacy, the sector is often limited by underdeveloped digital infrastructure, institutional inertia, and restricted organizational agility—elements that impede quick adaptation to changing market demands (Albukhitan, 2020). Digital transformation (DT) has become a strategic necessity for improving operational efficiency, promoting innovation, and reconfiguring traditional business models. However, transformation efforts are often hindered by internal resistance, lack of resources, and uneven technology adoption (Jones *et al.*, 2021). Importantly, DT should not be mistaken for a one-time technological upgrade, but instead viewed as a long-term, organization-wide strategic evolution that requires ongoing leadership commitment and incremental execution.

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Empirical evidence suggests that aligning IT capabilities with core business functions is essential for maximizing the benefits of transformation (Mikelsone *et al.*, 2021; Kraus *et al.*, 2022). Enterprise Resource Planning (ERP) systems, cloud-based platforms, and decision-support tools act as enablers of real-time coordination and resource optimization (Troisi *et al.*, 2020). Furthermore, technologies like Geographic Information Systems (GIS) and Internet of Things (IoT) devices contribute to environmental sustainability by enhancing process visibility and efficiency (Dwivedi *et al.*, 2022). Importantly, DT also holds the potential for indirect ecological benefits, including carbon emission reduction through paperless workflows, digital collaboration, and energy-efficient operations. However, concerns about e-waste and digital overconsumption necessitate careful governance. Therefore, effective digital management must strike a balance between technological expansion and sustainable practices.

This study adopts a Resource-Based Theory (RBT) perspective, supported by Dynamic Capabilities and Organizational Learning frameworks, to explore the phased digital transformation of a traditional Taiwanese manufacturing enterprise. Specifically, it aims to:

1. Examine the extent to which DT enhances cost and operational performance.
2. Evaluate the role of resource reallocation and digital infrastructure in advancing sustainability outcomes.
3. Investigate the evolution of managerial competencies and organizational learning across transformation phases.

By providing an integrated, multi-theoretical analysis of DT, this research offers valuable insights into how traditional firms can navigate complex transformation landscapes while promoting long-term capability development and competitive renewal.

2 Literature Review

Since the 1990s, the rapid advancement of digital technologies has transformed the strategic foundations of organizational design, decision-making, and value creation. Digital transformation (DT) is increasingly recognized as a multidimensional process that reshapes not only business models but also operational structures and cultural paradigms (Kraus *et al.*, 2021). As Morakanyane *et al.* (2017) argue, DT is not a finite project but an evolving journey of technological and organizational adaptation, requiring continual realignment to maintain competitive advantage.

Beyond merely adopting technology, effective DT requires reconfiguring the logic of value creation, designing business processes, and shifting the organizational mindset (Egodawele *et al.*, 2022). The emergence of smart manufacturing exemplifies this transformation by integrating automation, real-time data analytics, and system interoperability to enhance agility, responsiveness, and efficiency (Methuselah, 2024). These transitions also imply significant shifts in power structures, knowledge flows, and strategic resource allocation.

Despite its transformative potential, the literature also highlights the variability of DT outcomes. Organizational resistance, technological fragmentation, and cultural rigidity often limit impact (Jones *et al.*, 2021). Successful DT initiatives typically rely on the availability of digital infrastructure, strong IT capabilities, visionary leadership, and the effective orchestration of resources (Zhang *et al.*, 2022). Additional barriers include talent shortages, cybersecurity vulnerabilities, and strategic misalignment with market demands (Uzule & Verina, 2023).

In the context of Taiwanese SMEs, empirical evidence reveals both success stories and systemic challenges. For example, JD Design's implementation of ERP and cloud platforms during the COVID-19 pandemic enabled quicker responses to external shocks and fostered a data-driven decision culture. However, ongoing IT security gaps, resistance to change among veteran employees, and limited internal capabilities continue to hinder scalable digital transformation in resource-constrained settings.

To interpret such complex dynamics, Resource-Based Theory (RBT) provides a foundational lens by emphasizing internal capabilities as strategic assets. However, recent scholarship suggests that RBT must be complemented by Dynamic Capabilities Theory, which explains how firms adapt to volatility by reconfiguring resources, and Organizational Learning Theory (Argyris & Schön, 1996), which accounts for the cognitive and behavioral adjustments necessary for sustained transformation. Together, these perspectives highlight that DT is not merely a technological shift, but a long-term capacity-building process grounded in organizational evolution.

3 Methodology

This study employs a single-case design to explore the mechanisms and outcomes of digital transformation (DT) in a traditional manufacturing context. This qualitative approach is based on the methodological recommendations of Yin (2023), who emphasize the importance of contextual depth, data triangulation, and case richness for understanding complex organizational phenomena. The selected case company is a mid-sized, family-owned manufacturer of marine engine parts, located in Kaohsiung, Taiwan. This company was chosen for its representativeness of Taiwanese SMEs, its long operational history, and its structured and phased approach to digital transformation (DT) over the last decade.

The digital transformation process was implemented in three distinct phases. The first phase, Digitization (2014–2018), focused on converting core operations into digital workflows through the adoption of Enterprise Resource Planning (ERP) and Business Process Management (BPM) systems. This stage also integrated ISO 9001 quality protocols and emphasized the transition to paperless operations. The second phase, Digital Optimization (2018–2020), extended digital tools to both production and administrative departments. Networked machines enabled real-time data collection, while lean production methods were introduced to enhance operational agility and the accuracy of decision-making. The final phase, Digital Transformation (2020–2024), involved full-scale integration of internal and external systems, including the deployment of Supply Chain Management (SCM) platforms, AI-supported decision dashboards, and Internet of Things (IoT) infrastructure for predictive analytics and automated reporting.

To evaluate the human resource dimensions of transformation, this study adopts the theoretical lenses of Resource-Based Theory (RBT) and Competitive Dynamics Theory. RBT provides a foundation for understanding how internally embedded capabilities can be leveraged for strategic advantage, while Competitive Dynamics Theory examines how firms respond to shifts in competition and technology. Within this framework, five core managerial competencies are identified as critical for enabling successful DT: (1) professional knowledge and technical expertise, (2) IT system operation competence, (3) emergency response and problem-solving ability, (4) communication and cross-functional coordination skills, and (5) leadership and change management aptitude. These competencies are assessed longitudinally to track their evolution across each transformation phase.

Data were collected using a triangulated multi-source strategy. First, structured interviews were conducted with 17 participants representing three organizational levels: top executives, middle

managers, and frontline supervisors. Each interview lasted 60 to 90 minutes and followed a standardized protocol designed to elicit detailed narratives regarding digital initiatives, resistance mitigation, training processes, and strategic alignment. Second, a 17-item survey instrument was developed to assess the five competency dimensions using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Responses were later categorized as "qualified" and "unqualified" based on a cutoff of ≥ 4.0 to ensure consistent interpretation throughout the evaluation timeline.

An expert panel was convened to validate and enhance the reliability of managerial competency assessments. The panel included five members: two academic scholars in digital strategy and organizational learning, two senior industry consultants with over 15 years of experience in DT implementation, and one internal quality assurance director. Each expert conducted an independent evaluation of the managerial profiles and then participated in a consensus-building session. Inter-rater reliability was calculated using Cohen's Kappa, yielding a value of 0.84, which indicates strong agreement. Discrepancies were resolved through facilitated discussion and document review.

Qualitative interview data were analyzed using a three-stage coding process: open coding to generate initial categories, axial coding to link related concepts, and selective coding to refine theoretical connections aligned with the five competencies. NVivo software was used to manage and analyze the data corpus. Quantitative survey results illustrated changes in managerial capabilities across the three transformation phases—2018, 2021, and 2024—providing both cross-sectional and longitudinal perspectives on competence development.

4 Case Study

The focal company is a second-generation, family-owned OEM manufacturer of marine engine components based in Kaohsiung, Taiwan. In response to increasing competition, labor shortages, and quality inconsistencies, the firm initiated a structured digital transformation (DT) program in 2014. The transformation unfolded over a decade through three strategically designed phases—each with distinct objectives, implementation strategies, and organizational learning outcomes.

- Stage 1: Digitization (2014–2018)

This initial phase aimed to digitize essential business processes. The company introduced Enterprise Resource Planning (ERP) and Business Process Management (BPM) systems to manage quotations, procurement, and inventory operations, while integrating ISO 9001 quality management protocols. Key challenges included low digital literacy, resistance from long-tenured staff, and unclear project goals. These were addressed through mandatory IT training programs linked to performance evaluations, leadership-driven communication campaigns, and the implementation of progress-tracking dashboards. As a result, the organization achieved a significant reduction in manual data-entry errors and transitioned to over 90% paperless operations by the end of the phase. The total investment amounted to approximately USD 130,000, focused primarily on software licenses, consulting support, and internal process audits.

- Stage 2: Digital Optimization (2018–2020)

This phase expanded digital integration into production workflows and administrative processes. Networked machines facilitated real-time data collection on equipment status, while ERP systems were more deeply integrated across the supply chain and finance functions. Lean production tools such as visual control panels and automated scheduling modules were implemented. Resistance from frontline operators, particularly concerning dashboard

use, was addressed via weekly review meetings and feedback mechanisms that included frontline champions. This phase improved data-driven responsiveness and significantly diminished production cycle variability. An estimated 15% of the annual IT budget was allocated for equipment retrofitting, staff training, and enhancements to the KPI system.

- Stage 3: Digital Transformation (2020–2024)

The final phase centered on intelligent decision-making, real-time transparency, and external integration. The company created interactive dashboards for supervisors and managers, launched e-commerce integration with clients, and implemented Supply Chain Management (SCM) tools to monitor upstream and downstream data flows. Through academic-industry collaboration, an AI-based decision-support system was devised to forecast maintenance schedules and demand fluctuations. IoT sensors were installed to connect machine-level data with ERP databases, facilitating predictive analytics. Training programs emphasized data interpretation and autonomous control, advancing the organization toward greater digital maturity. By 2024, the organization had institutionalized digital routines across all functions and aligned its strategic vision with data-driven management principles.

Throughout all three phases, managerial capabilities were systematically assessed using a five-dimensional framework based on Resource-Based Theory. The dimensions included (1) professional expertise, (2) IT system operation, (3) emergency response agility, (4) communication and coordination, and (5) leadership. Evaluations by expert panels, along with internal review mechanisms, showed progressive improvements in each area. For instance, emergency response competency increased from 12% (2018) to 85% (2024), driven by scenario-based training and cross-functional drills. Leadership maturity, which was initially weak in guiding digital transitions, improved significantly as second-generation leaders took on more adaptive, learning-oriented roles.

Table 1 summarizes the core outcomes of the transformation process. The firm achieved significant operational improvements, including a reduction in order processing time from 20 hours to 1 hour, nearly complete elimination of ISO 9001 audit nonconformities, and a substantial increase in profit margins and competency qualification rates.

Table 1: Achievement of Goals at Each Stage of Transformation

Indicator	Target	2018	2021	2024	Achievement
Order Processing Time (hours)	≤ 2.0	20.0	4.5	1.0	Target surpassed
Paperless Completion Rate (%)	95%	4.5	96.5	98.4	Target achieved
ISO 9001 Audit Nonconformities	0	5	2	0	Target achieved
Profit Margin (%)	$\geq 30\%$	20.6	21.1	37.5	Target surpassed
Qualified Managerial Competence (%)	80%	0	60	96	Target achieved

5 Conclusion

This study shows that a strategically phased approach to digital transformation (DT) can provide significant benefits in operational efficiency, managerial development, and environmental performance within traditional manufacturing firms. By integrating ERP, BPM, and AI-based decision-support systems over a ten-year span, the case company successfully redesigned core processes, improved decision-making agility, and gradually established a data-driven management culture. These outcomes reinforce the idea that DT is not a one-time technological upgrade but a comprehensive organizational evolution, rooted in human capital investment, adaptive leadership, and resource orchestration.

From a theoretical perspective, the study validates the explanatory power of Resource-Based Theory (RBT) in understanding the internal drivers of digital transformation (DT) success, particularly highlighting the roles of managerial competencies and IT infrastructure as strategic enablers. Furthermore, the incorporation of dynamic capabilities and organizational learning perspectives adds analytical depth, illuminating how organizations learn, adapt, and restructure in response to digital pressures and operational constraints. Notably, this research contributes to the growing body of literature linking digitalization to sustainability outcomes, demonstrating how even resource-constrained firms can reduce their environmental impact through digital optimization, such as paperless workflows and energy-efficient operations.

In practical terms, the findings offer valuable guidance for traditional small and medium-sized enterprises (SMEs) embarking on digital transformation journeys. First, a staged implementation strategy, along with top-down leadership and bottom-up engagement, can help reduce resistance and enhance organizational commitment. Second, ongoing investment in developing managerial competencies is vital for embedding digital capabilities across departments. Third, collaboration with external partners, such as academic institutions or technology vendors, can fill internal capability gaps and speed up system adoption.

Nevertheless, several limitations must be acknowledged. The study is based on a single case within Taiwan's marine equipment manufacturing sector, which may constrain the generalizability of its findings. Factors such as firm size, family ownership structure, and cultural dynamics may limit the applicability of this model in other contexts. Additionally, while the study highlights environmental benefits such as paperless operations and improved energy efficiency, it lacks direct quantification of carbon emission reductions. Future studies should incorporate formal carbon accounting frameworks, such as the Greenhouse Gas Protocol or ISO 14064, to more precisely evaluate the sustainability impact of digital transformation.

Furthermore, while operational indicators such as protime and profit margins showed significant improvements, it is crucial to consider the influence of potential external factors. Macroeconomic recovery trends, policy incentives, and accelerated digital adoption resulting from the COVID-19 pandemic may have affected this trend. Future research should adopt a more controlled or comparative design to isolate the causal mechanisms driving performance gains.

Future research should also explore comparative case studies across various industries and regions to examine how digital transformation (DT) unfolds under different institutional and market conditions. Additionally, incorporating external environmental factors, such as regulatory policies, customer digital maturity, or supply chain digitalization, would provide a more comprehensive understanding of DT's impact. Quantitative methods, including Data Envelopment Analysis (DEA) and carbon cost accounting, could improve the accuracy of performance assessments. Longitudinal studies across multiple transformation cycles are particularly valuable for uncovering causal mechanisms and evaluating long-term digital sustainability.

In conclusion, this study affirms that traditional firms can achieve meaningful transformation by strategically aligning digital technologies with organizational capabilities. Digital transformation should be viewed not merely as an IT investment, but as a sustained strategic process of capability building, cultural evolution, and long-term competitiveness.

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