JOURNAL OF CULTURAL ANALYSIS AND SOCIAL CHANGE

Journal of Cultural Analysis and Social Change,
2025, 10(3), 3297-3310
ISSN: 2589-1316

Applications of Artificial Intelligence for Enhancing Digital Administrative Performance: How and When Senior Management Drives Digital Transformation in Jordanian Food Industry Companies

Marwan Ahmed Yousif Al-Obaidi[1*], Ahmed Turki[2]

[1] *PhD Researcher, Department of Business Administration, Faculty of Economics and Management University of Sfax, Sfax, Tunisia; marwan.ah100@gmail.com*
[2] *Associate Professor, Department of Business Administration, Faculty of Economics and Management, University: University of Sfax, Sfax, Tunisia; ahmed.turki@ihecs.usf.tn*

*Corresponding Author: marwan.ah100@gmail.com

Citation: Al-Obaidi, M. A. Y. & Turki, A. (2025). Applications of Artificial Intelligence for Enhancing Digital Administrative Performance: How and When Senior Management Drives Digital Transformation in Jordanian Food Industry Companies, *Journal of Cultural Analysis and Social Change*, 10(3), 3297-3310. https://doi.org/10.64753/jcasc.v10i3.4306

Published: December 11, 2025

ABSTRACT

Artificial intelligence (AI) has become a transformative force in organizational management, driving automation, data-driven decisions, and digital efficiency. This study examines the application of AI in enhancing digital administrative performance and explores how and when top management interventions influence digital transformation within Jordan's food manufacturing sector. The research focuses on four companies Siniora Food Industries, Kasih Food Manufacturing Group, Petra Juice Concentrates, and Jaddo Sweilem Factory for Halva and Tahini using a mixed-methods approach that combines survey data (n = 178) with executive interviews. Guided by the Technology–Organization–Environment (TOE) framework and Dynamic Capabilities Theory, the analysis using PLS-SEM reveals that AI adoption significantly improves administrative efficiency ($\beta = 0.321$, $p < 0.001$). Top management support ($\beta = 0.298$, $p < 0.001$) and the timing of managerial intervention ($\beta = 0.215$, $p < 0.01$) further strengthen performance outcomes. Mediation analysis confirms that process automation and data-driven decision-making are the key pathways through which AI enhances digital effectiveness. The findings emphasize that early, proactive executive engagement ensures smoother technological integration and higher organizational readiness. The study contributes by integrating the concept of timing into digital-leadership research and provides a practical framework for industries in developing economies to achieve sustainable digital excellence.

Keywords: Artificial Intelligence, Digital Transformation, Administrative Performance, Leadership Timing, Jordanian Food Industry.

INTRODUCTION

Over the past decade, artificial intelligence (AI) has evolved from a futuristic concept into one of the most transformative forces in organizational management and industrial development. AI applications ranging from predictive analytics, process automation, and machine learning to intelligent decision-support systems have redefined how organizations manage administrative, operational, and strategic functions (Vial, 2019; Sousa & Rocha, 2019). Within this paradigm shift, *digital administrative performance* has emerged as a critical determinant of organizational competitiveness, efficiency, and adaptability. Modern firms no longer compete solely through product quality or cost efficiency but increasingly through their ability to digitize internal processes, automate

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administrative workflows, and make data-driven decisions (Westerman, Bonnet, & McAfee, 2014; Matt, Hess, & Benlian, 2015).

The integration of AI into administrative systems now represents a cornerstone of digital transformation strategies worldwide. Governments and industries alike are investing heavily in AI-driven platforms to streamline workflows, reduce human error, and enhance decision-making speed and accuracy (Alshadoodee, Mansoor, Kuba, & Gheni, 2022). In developing economies such as Jordan, digital transformation signifies not only a technological revolution but also an organizational and cultural transition requiring visionary leadership, institutional support, and strategically timed executive interventions (Vial, 2019; Tornatzky & Fleischer, 1990).

The Jordanian food industry plays a vital role in the national economy by contributing substantially to GDP, employment, and export revenues (Tranter, 2020). In recent years, the sector has gradually embraced Industry 4.0 technology automation, digital monitoring, and data analytics to enhance production quality, traceability, and supply-chain management. However, while production processes have benefited from digitization, administrative and managerial functions such as finance, human resources, procurement, and logistics coordination often remain semi-manual or poorly integrated with AI systems. This fragmentation constrains organizational agility and transparency, limiting the sector's competitiveness regionally and internationally (Worapongpat, 2025).

A central challenge in digital transformation is determining how and when senior management should intervene to ensure successful AI adoption within administrative functions. Many firms invest heavily in technology yet fail to realize expected gains due to poor timing of executive action, lack of sustained commitment, or misalignment between technological and human capacities (Vial, 2019; Westerman et al., 2014). Senior management plays a decisive role in shaping digital vision, allocating resources, and establishing governance mechanisms that define the pace and scope of transformation. The *timing* of managerial involvement, whether in early planning, mid-implementation, or post-deployment significantly influences outcomes. Early and proactive leadership engagement often yields smoother integration, stronger employee acceptance, and faster returns on investment (Teece, 2018; Iwadi, Ali, Jabari, & Sukic, 2024).

The Jordanian food manufacturing sector offers an especially relevant context for exploring this intersection of leadership, timing, and digital performance. The sector includes firms with varying levels of digital maturity: large, globally oriented enterprises like Siniora Food Industries; mid-sized innovators such as Kasih Food Manufacturing Group and Petra Juice Concentrates; and smaller, family-owned factories such as Jaddo Sweilem Factory for Halva and Tahini. This diversity provides a natural laboratory for comparing how organizational size, resources, and managerial behavior influence AI adoption. While larger firms such as Siniora have already embedded AI into their enterprise resource-planning systems and predictive-quality analytics, smaller firms continue to rely on manual data entry or fragmented software, mirroring patterns seen in other developing-country industries (Aloqaily & Rawash, 2022; Abdulrazzaq, 2025). Understanding how executive timing and support shape these differences is crucial for designing effective strategies for industrial modernization and competitiveness.

From a theoretical standpoint, this study is anchored in several complementary frameworks. The Technology–Organization–Environment (TOE) model explains how technological readiness, organizational structure, and environmental pressures jointly influence AI adoption (Tornatzky & Fleischer, 1990). The Dynamic Capabilities Theory (Teece, 2018) offers insight into how firms sense digital opportunities, seize them through strategic initiatives, and reconfigure resources to sustain competitiveness. Additionally, Socio-Technical Systems Theory underscores the need for alignment among technological, human, and organizational subsystems to ensure sustainable transformation (Vial, 2019). Together, these frameworks capture the multi-dimensional nature of digital transformation and clarify the central role of leadership timing as a dynamic managerial capability.

From a practical perspective, digital transformation is a continuous, staged process rather than a one-time technological event. Each phase depends heavily on executive foresight, particularly the capacity to prioritize initiatives, allocate resources effectively, and maintain workforce engagement (Adnan et al., 2021). Poorly timed interventions, such as deploying AI before workforce training or data harmonization, can create inefficiencies and resistance, while proactive alignment of technology and human readiness accelerates adoption and performance gains (Mansoor et al., 2025).

In Jordan, recent national initiatives most notably the National AI Strategy (2023–2030) and the Digital Economy and Entrepreneurship Policy reinforce the urgency of integrating AI into industrial operations. Yet, the success of these macro-level policies hinges on how individual firms operate them internally (Vial, 2019). Within the food industry, organizations face distinct pressures, stringent quality standards, volatile supply chains, and complex compliance requirements that make AI particularly valuable. AI-enabled solutions such as predictive maintenance, automated procurement, digital traceability, and HR analytics offer pathways to meet these challenges, but administrative units must evolve alongside production functions to realize the full benefits (Al-Sabaawe etal., 2020; Ufomba, Judith, & Daniel, 2024).

This study therefore addresses a critical gap by investigating how AI applications enhance digital administrative performance and how the timing of top-management interventions affects this process in four representative

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Jordanian food companies. It aims to uncover success patterns and leadership behaviors that determine AI adoption effectiveness and to propose a framework for guiding future digital-transformation initiatives across similar industries. The research contributes theoretically by integrating the concept of timing into digital-transformation and leadership literature, an aspect rarely analyzed in existing models (Matt et al., 2015; Teece,2018)and empirically by providing fresh evidence from the Middle East, complementing studies conducted primarily in Western contexts. Practically, it offers strategic insights for Jordanian policymakers and industrial leaders, demonstrating how AI-driven administrative systems can strengthen efficiency, transparency, and competitiveness (Aloqaily & Rawash, 2022; Iwadi et al., 2024).

In conclusion, the digital transformation trajectory of Jordan's food industry reflects the broader challenges faced by developing economies seeking to modernize through AI. By analyzing *how and when* senior executives drive AI adoption and administrative performance, this study contributes actionable insights for aligning technological innovation with human and organizational readiness. Its findings are expected to enrich academic theory and inform national industrial policy, advancing Jordan's ambition to become a regional hub for smart, sustainable, and digitally empowered industry (Vial, 2019; Westerman et al., 2014).

LITERATURE REVIEW

Artificial Intelligence and Digital Transformation

Artificial Intelligence (AI) is increasingly recognized as the central driver of the fourth industrial revolution (Industry 4.0), transforming both operational and administrative functions across organizations (Brynjolfsson & McAfee, 2017; Davenport & Ronanki, 2018). AI refers to systems capable of performing tasks that normally require human intelligence such as perception, reasoning, learning, and decision-making through machine learning, natural language processing, and predictive analytics (Haenlein & Kaplan, 2019). In the business context, AI enables process automation, optimization of resource allocation, and generation of actionable insights from large data sets.

The transition from traditional to digital administrative performance involves the integration of AI-driven systems into management, human resources, procurement, accounting, and customer relationship functions. Scholars such as Westerman et al. (2014) emphasize that digital transformation is not merely technological adoption, but a strategic reconfiguration of processes, culture, and leadership. Administrative transformation, therefore, goes beyond digitizing paperwork it entails redesigning workflows to enable intelligent decision-making, predictive analytics for planning, and self-learning systems that support administrative efficiency (Sousa & Rocha, 2019).

In developing economies, including Jordan, digital transformation faces additional barriers such as limited infrastructure, insufficient digital skills, and high implementation costs (Al-Omoush et al., 2021). Despite these challenges, industries have begun to recognize AI as a key tool for improving efficiency, reducing human error, and enhancing competitiveness. The food manufacturing sector, characterized by complex supply chains and stringent quality requirements, is particularly well-suited for AI integration (Tranter, 2020). However, the adoption of AI within administrative departments as opposed to production or quality control remains limited and under-researched.

Artificial Intelligence in Administrative and Managerial Functions

AI applications are transforming administrative management through automation, prediction, and personalization. In human resources, AI supports recruitment, performance evaluation, and training analytics (Bessen, 2019). In finance, algorithms detect anomalies, forecast revenues, and automate reporting (Huang & Rust, 2021). Within procurement and logistics, intelligent systems optimize supplier selection and inventory management (Cheng et al., 2020). These developments contribute directly to digital administrative performance, defined as the efficiency, accuracy, and responsiveness of management processes under digitalization. However, the effectiveness of AI depends not only on technological capability but also on organizational readiness and managerial vision. A study by Kane et al. (2019) found that firms that align AI initiatives with business strategy experience significantly higher performance gains than those implementing AI in isolated processes. Similarly, Dwivedi et al. (2021) note that administrative digitalization requires cultural change, data governance, and leadership commitment. Thus, leadership behavior and timing are critical to sustaining transformation momentum.

The Role of Top Management Support in Digital Transformation

Top management support (TMS) is consistently identified as one of the strongest predictors of successful digital transformation (Teece, 2018; Li et al., 2022). Executive leaders influence transformation through strategic

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vision, resource allocation, and cultural reinforcement. When top management actively sponsors digital initiatives, employees perceive greater legitimacy and urgency in adopting new technologies (Westerman et al., 2014).

Empirical evidence highlights several mechanisms through which TMS enhances digital outcomes:

1. Vision and Alignment: Executives set the digital vision and ensure its alignment with organizational strategy (Kane et al., 2019).
2. Resource Commitment: Leaders allocate financial, human, and technological resources to sustain digital projects (Hess et al., 2016).
3. Governance and Oversight: Establishing cross-functional teams and steering committees ensures accountability and progress tracking (Brock & von Wangenheim, 2019).
4. Cultural Change: Leadership behavior shapes the digital mindset, encouraging innovation and data-driven decision-making (Li et al., 2022).

In the Jordanian context, research by Al-Dmour et al. (2021) found that managerial commitment and leadership readiness are decisive factors in digital transformation success, particularly in family-owned and medium enterprises. This indicates that the human and managerial dimensions of transformation often outweigh purely technical factors.

Timing of Management Intervention in Digital Transformation

While leadership support is widely acknowledged, the timing of such support remains an underexplored dimension. Studies in innovation management and change theory suggest that early managerial intervention during the planning and pilot stage is more effective than reactive support during later phases (Kotter, 2012; Teece, 2018). Timing affects employee engagement, budget prioritization, and the ability to overcome resistance to change.

Researchers such as Matt et al. (2015) argue that digital transformation unfolds in stages: (1) exploration, (2) experimentation, (3) integration, and (4) institutionalization. Each stage requires different levels and types of management involvement. Early stages benefit from visionary leadership and resource mobilization, while later stages require control and integration mechanisms. Premature withdrawal or delayed engagement by senior management often results in fragmented or stalled transformation initiatives (Vial, 2019). In developing countries, the timing dimension becomes even more critical because of limited resources and low digital maturity. Delayed decisions in technology investment or workforce training can lead to obsolescence or misalignment with global market trends. Hence, identifying when top management should intervene is as important as understanding how they should act.

Digital Administrative Performance

Digital administrative performance (DAP) reflects the extent to which digital technologies improve the efficiency, accuracy, and strategic value of administrative operations. Scholars have proposed various indicators to measure DAP, including process speed, cost reduction, error minimization, user satisfaction, and decision-making quality (Sousa & Rocha, 2019; Li et al., 2022).

In AI-driven organizations, administrative performance improvement typically manifests in three dimensions:

1. **Efficiency:** Automation reduces manual workload, shortens processing time, and minimizes administrative errors.
2. **Intelligence:** Data analytics supports predictive and evidence-based management decisions.
3. **Integration:** Digital systems unify data flows across departments, improving coordination and transparency.

Recent studies (Dwivedi et al., 2021; Ghobakhloo, 2020) show that companies achieving high digital administrative performance often display three enablers: (a) sustained leadership commitment, (b) strong data governance, and (c) continuous learning culture. In the food industry, where traceability and compliance are essential, these factors translate into operational excellence and enhanced consumer trust.

THEORETICAL FOUNDATIONS

a. Technology–Organization–Environment (TOE) Framework Developed by Tornatzky and Fleischer (1990), the TOE framework explains the conditions influencing technology adoption.

- **Technology dimension:** The perceived benefits, complexity, and compatibility of AI tools.
- **Organization dimension:** Firm size, managerial support, culture, and readiness.
- **Environmental dimension:** Competitive pressure, regulation, and customer demand.

In Jordan's food industry, environmental pressure from export markets and compliance regulations pushes firms toward digitalization, while organizational readiness and leadership determine the success of adoption.

b. Dynamic Capabilities Theory Teece (2018) describes dynamic capabilities as a firm's ability to sense opportunities, seize them, and reconfigure resources. Leadership timing relates to this theory: managers must *sense*

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technological shifts early, *seize* opportunities through investment, and *reconfigure* structures to support AI integration. Firms that delay sensing or resource mobilization risk lagging behind technologically advanced competitors.

c. Socio-Technical Systems (STS) Theory The STS perspective emphasizes the joint optimization of social and technical subsystems. Implementing AI without aligning it with human skills, roles, and culture often leads to resistance or underutilization (Bostrom & Heinen, 1977). In administrative settings, STS suggests that successful transformation depends on the interaction between digital systems and the people who use them highlighting the need for leadership in guiding cultural adaptation.

Empirical Studies in the Jordanian and Regional Context

Research in the Middle East and Jordan has primarily focused on operational digitalization and Industry 4.0 readiness, with limited attention to administrative AI adoption. Al-Qudah et al. (2022) found that Jordanian industrial firms exhibit moderate digital maturity, with most digital initiatives concentrated in production rather than management. Similarly, Abu-Shanab and Haider (2020) observed that managerial awareness and top management vision strongly influence digital transformation outcomes across Jordanian SMEs. In the food industry specifically, Al-Tahat (2021) reported that Jordanian food manufacturers are increasingly using data analytics for supply chain optimization but lag in administrative automation. Resistance to change, limited technical training, and fragmented leadership initiatives were identified as major barriers. These findings underscore the relevance of studying how leadership timing and AI adoption jointly shape digital administrative performance. Comparable studies in neighboring contexts provide supporting evidence. In Saudi Arabia, Alghamdi et al. (2021) found that early executive sponsorship and digital leadership culture significantly improved AI project success rates in manufacturing firms. Similarly, in Egypt and the UAE, proactive digital governance and structured leadership intervention reduced implementation failure rates by nearly 40% (Elbanna & Dwivedi, 2022). Collectively, these findings indicate that leadership timing is not only context-specific but also culturally and institutionally influenced. In collectivist cultures such as Jordan's, hierarchical decision-making may delay transformation initiatives unless senior management communicates a clear and sustained vision.

Research Gaps

Despite the growing literature on AI and digital transformation, several gaps remain:

1. Limited focus on administrative functions: Most studies emphasize production automation, ignoring back-office transformation.
2. Underrepresentation of Middle Eastern contexts: Empirical studies in Jordan and similar economies are scarce, limiting generalizability.
3. Neglect of timing dynamics: Few studies explicitly analyze *when* top management should intervene for maximum transformation success.
4. Sector-specific analysis: The food industry, despite its economic importance, remains understudied in AI-related management research.

Integration of multi-theoretical perspectives: Few models combine TOE, Dynamic Capabilities, and STS to explain administrative performance outcomes.

METHODOLOGY

Research Design

This study employs a mixed-methods explanatory sequential design to investigate *how* and *when* top management interventions influence the effectiveness of artificial intelligence (AI) applications in enhancing digital administrative performance within Jordanian food manufacturing companies. The design combines qualitative exploration with quantitative validation. The qualitative phase identifies managerial practices, leadership behaviors, and contextual enablers influencing AI-based digital transformation. The quantitative phase empirically evaluates the conceptual model and hypotheses derived from the first stage using survey data. This combination provides both depth and generalizability, allowing a holistic understanding of AI-driven transformation in real organizational settings. The unit of analysis is the *administrative management level* (finance, HR, procurement, IT, and operations support) in each company where digital initiatives are managed and executed.

Research Context and Case Selection

National Context: The study is situated in the Hashemite Kingdom of Jordan, a rapidly developing economy that is positioning itself as a regional leader in digital transformation under the National Artificial Intelligence Strategy (2023–2030). Although Jordan demonstrates strong governmental commitment to digitalization, the

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private industrial sector particularly food manufacturing still exhibits varying levels of AI maturity. This creates an ideal environment to examine the role of leadership timing and digital readiness in successful transformation.

Industrial Context: The Jordanian food manufacturing industry is one of the country's most dynamic sectors, contributing significantly to GDP and exports. It faces growing pressure to adopt digital systems for supply chain transparency, quality control, and efficiency enhancement. However, many firms continue to rely on semi-manual administrative systems, especially in financial management, human resources, and procurement. Understanding how AI applications can enhance administrative functions and how top management leadership and timing facilitate this process is essential for improving competitiveness and operational resilience.

Case Selection: The study adopts a purposive multiple-case design covering four companies that reflect the full spectrum of digital maturity levels in the Jordanian food industry. Each case represents a unique combination of technological capability, leadership structure, and transformation stage.

Company	Profile	Rationale for Inclusion
Siniora Food Industries PLC	A large-scale, export-oriented manufacturer with advanced ERP systems and AI-driven quality analytics.	Represents a *digitally mature benchmark* ideal for identifying best practices and leadership frameworks.
Kasih Food Manufacturing Group	Medium-sized enterprise specializing in food spreads and ready meals, with partial automation and pilot AI modules.	Illustrates a *transitional stage* between traditional and fully digital management systems.
Petra Juice Concentrates Company	Medium-sized processors of fruit concentrates, using data analytics for forecasting and inventory control.	Demonstrates *functional digitalization* in specific administrative areas.
Jaddo Sweilem Factory for Halva and Tahini	A small, family-owned business beginning its digital journey, with limited automation.	Reflects *low digital maturity* and highlights readiness and timing challenges.

This purposeful sampling allows for comparative analysis across organizational sizes, resources, and leadership strategies, yielding insights into *how* and *when* managerial actions shape digital success.

Research Population and Sampling

Population

The research population includes administrative and managerial employees working in functions directly affected by digital transformation namely:

- Information Technology / Digital Transformation
- Finance and Accounting
- Human Resources
- Procurement and Supply Chain
- Operations and Quality Administration

Sampling Approach

Two participant groups are targeted:

1. ***Qualitative Phase:*** Senior executives and department heads (approximately 3–4 per company), including CEOs, digital transformation officers, HR directors, and IT managers (total n ≈ 15).
2. ***Quantitative Phase:*** Administrative and mid-level managers who interact with AI or digital tools in daily operations (n ≈ 150–200 total respondents across the four firms).

The sampling approach is purposive and representative, ensuring that all key managerial roles involved in digital transformation are captured.

Conceptual Model and Research Variables

The conceptual framework integrates two theoretical perspectives:

- The Technology–Organization–Environment (TOE) framework (Tornatzky & Fleischer, 1990)
- The Dynamic Capabilities Theory (Teece, 2018)

This integration enables the analysis of both external pressures and internal strategic actions affecting AI adoption and performance outcomes.

Variable Type	Variable	Definition / Measurement Focus
Independent Variables	AI Adoption (AIA)	The degree to which AI tools (e.g., automation, analytics, chatbots, predictive modeling) are implemented in administrative processes.
	Top Management Support (TMS)	Executive-level commitment through leadership, budgeting, and policy guidance.
	Timing of Intervention (TIM)	The stage (early, mid, late) at which senior management actively supports or directs digital initiatives.

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Mediating Variables	Process Automation (PA)	The extent to which repetitive administrative tasks are automated.
	Data-Driven Decision-Making (DDD)	The use of AI analytics for managerial and strategic decision-making.
Dependent Variable	Digital Administrative Performance (DAP)	The overall efficiency, accuracy, and agility of administrative functions after AI integration.
Moderating Variables	Company Size / Digital Infrastructure	Organizational capacity that influences the strength of relationships between leadership and performance.

Data Collection Procedures

Phase I: Qualitative Exploration The first phase explores managerial practices and organizational contexts to understand *how* and *when* top management interventions occur during AI adoption.

Data Sources:

- ***Semi-structured Interviews:*** Conducted with executives and department heads in each company.
- ***Document Review:*** Analysis of company reports, digital transformation strategies, and internal policies.
- ***Field Observation (when possible):*** *On*-site visits to observe workflow automation, digital documentation systems, and employee interactions with AI platforms.

Analysis: Data are transcribed and analyzed using NVivo software. A thematic analysis approach identifies recurring patterns relating to leadership timing, AI integration challenges, and administrative outcomes. These themes guide the refinement of survey items for the quantitative stage.

Phase II: Quantitative Validation

The second phase empirically validates the relationships proposed in the conceptual model using survey data.

Instrument Design: A structured questionnaire is developed using five-point Likert scales (1 = Strongly Disagree to 5 = Strongly Agree). Items are adapted from prior validated instruments (Westerman et al., 2014; Dwivedi et al., 2021; Li et al., 2022).

Questionnaire Sections:

1. ***Demographic Data:*** Company, department, role, experience, and digital exposure.
2. ***AI Adoption (AIA):*** 6 items (e.g., "AI systems are integrated into our administrative workflows").
3. ***Top Management Support (TMS):*** 5 items (e.g., "Senior management provides continuous resources for digital projects").
4. ***Timing of Intervention (TIM):*** 4 items (e.g., "Top management participated in digital planning from the initial stages").
5. **P*rocess Automation (PA) & Data-Driven Decision-Making (DDD):*** 8 items measuring automation and analytical decision reliance.
6. ***Digital Administrative Performance (DAP):*** 6 items (e.g., "Administrative tasks are completed faster and more accurately due to AI tools").

Pilot Testing: The survey is pre-tested with 20 employees from similar companies to assess clarity and reliability. Necessary linguistic and structural adjustments are made before full deployment.

Data Collection:

- Conducted over a four-week period.
- Surveys distributed via online forms (Google Forms/Qualtrics) and physical copies where necessary.
- A total of 150–200 valid responses are targeted for robust statistical power.

Reliability and Validity

Content Validity: Ensured through expert review by three academics in digital transformation and two industry professionals for conceptual alignment and clarity.

Construct Validity:

- Exploratory Factor Analysis (EFA): To assess item dimensionality.
- Confirmatory Factor Analysis (CFA): To evaluate convergent validity (AVE > 0.5) and discriminant validity (Fornell–Larcker criterion).

Reliability: Cronbach's Alpha and Composite Reliability values above 0.70 indicate internal consistency.

Common Method Bias: Controlled via anonymity assurances, randomized question order, and Harman's single-factor test.

Data Analysis Techniques

The analytical process proceeds in two main stages:

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Stage 1: Qualitative Analysis

- Data coding and theme generation using NVivo 14.
- Cross-case synthesis comparing leadership behavior and timing across the four companies.
- Development of a *qualitative narrative model* describing managerial pathways toward digital success.

Stage 2: Quantitative Analysis

Conducted using SPSS 27 and SmartPLS 4, including:

1. ***Descriptive Statistics***: Means, standard deviations, and demographic breakdowns.
2. ***Measurement Model Testing:*** Reliability, validity, and loading analysis.
3. ***Structural Model Evaluation:*** Path coefficients and significance testing through Partial Least Squares Structural Equation Modeling (PLS-SEM).
4. ***Mediation and Moderation Analysis:*** Examining indirect effects of Process Automation and DDD, and moderating effects of company size/infrastructure.
5. ***Multi-Group Analysis (MGA):*** Comparing results among the four companies to identify digital maturity variations.

Bootstrapping (5,000 samples) is used to evaluate significance at $p < 0.05$.

3.8 Ethical Considerations

Ethical standards are rigorously maintained throughout the study.

- Informed Consent: All participants are briefed on the study's aims, procedures, and voluntary nature.
- Confidentiality: Identities of participants and organizations are anonymized in all published materials.
- Data Protection: All data are securely stored and used exclusively for academic purposes.
- Institutional Approval: Permissions are obtained from company management and the university ethics committee prior to fieldwork.

RESULTS AND ANALYSIS

This section presents the empirical results of the study examining how and when top management interventions influence artificial intelligence (AI) adoption and digital administrative performance within the Jordanian food manufacturing sector. Data were collected from 178 respondents representing four firms Siniora Food Industries, Kasih Food Manufacturing Group, Petra Juice Concentrates, and Jaddo Sweilem Factory for Halva and Tahini supplemented by 15 semi-structured executive interviews. The data analysis followed the recommended PLS-SEM approach (Hair et al., 2021), including descriptive statistics, reliability and validity testing, structural model evaluation, and mediation–moderation analysis. All quantitative analyses were performed using SPSS v.27 and SmartPLS v.4.

Descriptive Statistics

The respondent group comprised 63.5% male and 36.5% female participants, primarily between the ages of 35–44 years (39.9%) and holding a bachelor's degree (69.7%). The distribution across departments included Finance (23.6%), HR (21.9%), IT/Digital Transformation (20.8%), Procurement (17.4%), and Operations Support (16.3%). This variety ensures the data reflect a comprehensive view of administrative functions across the food industry.

The descriptive analysis of the study constructs is shown below.

Construct	Mean	SD	Minimum	Maximum	Interpretation
AI Adoption (AIA)	3.91	0.71	2.10	4.90	Moderate-to-high
Top Management Support (TMS)	4.12	0.68	2.40	5.00	High
Timing of Intervention (TIM)	3.84	0.79	1.90	5.00	Moderate-to-high
Process Automation (PA)	3.77	0.74	2.20	4.90	Moderate
Data-Driven Decision-Making (DDD)	3.88	0.69	2.00	5.00	Moderate-to-high
Digital Administrative Performance (DAP)	4.03	0.66	2.30	5.00	High

Respondents reported the strongest agreement with Top Management Support (M = 4.12) and Digital Administrative Performance (M = 4.03), reflecting leadership's active engagement and tangible improvements in administrative efficiency following AI implementation.

Correlation Analysis

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Pearson's correlations indicated positive and significant relationships among all constructs.

Variable	AIA	TMS	TIM	PA	DDD	DAP
AIA	1					
TMS	.68**	1				
TIM	.55**	.62**	1			
PA	.61**	.59**	.52**	1		
DDD	.63**	.58**	.49**	.66**	1	
DAP	.71**	.67**	.58**	.63**	.69**	1

(**p < 0.01)

AI adoption, managerial support, and timing all exhibit strong associations with digital administrative performance, preliminarily confirming the conceptual model.

Reliability and Validity Assessment

Cronbach's alpha values ranged between 0.857 and 0.918, and composite reliability (CR) values ranged from 0.892 to 0.936, exceeding the recommended threshold of 0.70. Average Variance Extracted (AVE) values ranged from 0.657 to 0.714, indicating convergent validity. The Fornell–Larcker criterion confirmed discriminant validity, as the square roots of AVE were greater than inter-construct correlations. The Heterotrait–Monotrait (HTMT) ratios were below 0.85, confirming construct independence.

Structural Equation Modeling (PLS-SEM)

The PLS-SEM results revealed strong explanatory and predictive capabilities. The model explained 68.4% of the variance ($R^2 = 0.684$) in Digital Administrative Performance, 57.9% in Process Automation, and 61.2% in Data-Driven Decision-Making. The Standardized Root Mean Square Residual (SRMR) was 0.061, confirming a good model fit (< 0.08).

Hypothesis	Path	β	t-value	p-value	Result
H1	AIA → DAP	0.321	6.82	<0.001	Supported
H2	TMS → DAP	0.298	5.77	<0.001	Supported
H3	TIM → DAP	0.215	4.26	<0.01	Supported
H4	AIA → PA → DAP	0.137	3.94	<0.01	Supported
	AIA → DDD → DAP	0.184	4.22	<0.01	Supported
	TMS × TIM → DAP	0.112	2.87	<0.05	Supported

The results confirm that all direct, mediating, and moderating relationships are statistically significant. AI adoption exerts the strongest direct impact on performance (β = 0.321), followed by top management support (β = 0.298). The moderating effect of timing (β = 0.112, $p < 0.05$) indicates that early leadership involvement amplifies the positive influence of management support on performance outcomes.**4.6 Regression Analysis Verification**

A multiple regression model was used to validate the SEM results. $R^2 = 0.676$, Adjusted $R^2 = 0.664$, $F(5,172) = 71.83$, $p < 0.001$

Predictor	β	t-value	p-value
AI Adoption	0.294	6.62	<0.001
Top Management Support	0.278	6.09	<0.001
Timing of Intervention	0.208	4.98	<0.001
Process Automation	0.157	3.86	<0.01
Data-Driven Decision-Making	0.193	4.21	<0.01

Both analyses confirm consistent direction and magnitude of effects, strengthening model validity.

Mediation and Moderation Results

The mediation analysis demonstrates that AI adoption improves digital administrative performance indirectly through Process Automation (β = 0.137, $p < 0.01$) and Data-Driven Decision-Making (β = 0.184, $p < 0.01$). These findings suggest that AI's benefits materialize through enhanced process integration and analytical decision-making rather than through direct substitution of human effort.The moderation analysis shows that the Timing of Intervention significantly strengthens the TMS–DAP relationship (β = 0.112, $p < 0.05$). Early involvement of senior management during planning stages yields higher alignment, resource readiness, and reduced employee resistance.

ANOVA and Group Comparison

A one-way ANOVA revealed significant differences in Digital Administrative Performance among the four firms, $F(3,174) = 14.28$, $p < 0.001$.

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Company	Mean DAP	SD
Siniora	4.38	0.47
Kasih	4.12	0.51
Petra Juice	3.94	0.55
Jaddo Sweilem	3.61	0.59

Post-hoc (Tukey) tests confirmed that Siniora's performance is significantly higher than Petra Juice ($p < 0.05$) and Jaddo Sweilem ($p < 0.001$). This pattern reflects varying degrees of digital maturity: Siniora leads in digital readiness, while Jaddo Sweilem lags due to limited automation and late managerial involvement.

Multi-Group Analysis (MGA)

A multi-group analysis was conducted to compare path coefficients across the four firms.

Relationship	Siniora	Kasih	Petra	Jaddo	Interpretation
AIA → DAP	0.42***	0.31**	0.28**	0.19*	AI effect strongest in Siniora
TMS → DAP	0.36***	0.29**	0.25*	0.18 (ns)	Leadership more effectively in larger firms
TIM → DAP	0.27**	0.21*	0.17*	0.11 (ns)	Early involvement critical
R^2 (DAP)	0.72	0.66	0.59	0.41	Explanatory power declines with lower digital maturity

(*p < 0.05, **p < 0.01, ***p < 0.001)

Siniora's leadership and advanced infrastructure produced the strongest AI–performance link. Kasih and Petra demonstrated moderate digital performance, while Jaddo Sweilem reflected low readiness and delayed managerial engagement

Effect Size and Predictive Power

Endogenous Variable	R^2	f^2	Q^2	Interpretation
Digital Administrative Performance	0.684	0.37	0.48	High explanatory power
Process Automation	0.579	0.29	0.39	Medium
Data-Driven Decision-Making	0.612	0.31	0.41	Medium–high

The f^2 values (0.29–0.37) indicate medium-to-large effect sizes, and $Q^2 > 0$ confirms strong predictive relevance. These statistics affirm the model's robustness and capacity to forecast administrative performance improvements.

Departmental Comparisons

Department	Mean AI Adoption	Mean DAP	Observation
IT/Digital Transformation	4.45	4.34	Highest due to advanced system usage
Finance	3.97	4.18	Automation of reporting and analytics
HR	3.75	3.98	Moderate AI-based analytics integration
Procurement	3.64	3.86	Emerging adoption trend
Operations Support	3.59	3.73	Lowest digital exposure

Departments most exposed to technology (IT and Finance) reported the greatest performance improvements, confirming the operational validity of AI adoption within administrative domains.

Summary of Hypotheses Testing

Hypothesis	Statement	Result	Statistical Support
H1	AI Adoption positively affects Digital Administrative Performance.	Supported	$\beta = 0.321$, $p < 0.001$
H2	Top Management Support positively affects Digital Administrative Performance.	Supported	$\beta = 0.298$, $p < 0.001$
H3	Timing of Intervention positively moderates the AI–DAP relationship.	Supported	$\beta = 0.112$, $p < 0.05$
H4	Process Automation and Data-Driven Decision-Making mediate the AI–DAP relationship.	Supported	$\beta = 0.137$–0.184, $p < 0.01$

All four hypotheses were supported, confirming the robustness of the conceptual model.

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INTEGRATED DISCUSSION OF RESULTS

The results collectively demonstrate that AI adoption is a critical driver of administrative modernization, yet its success depends on the leadership behavior and timing of executive interventions. Companies with proactive and early managerial engagement (notably Siniora) achieved the highest administrative efficiency and responsiveness. Process automation and data-driven culture emerged as essential mediators that translate AI investment into tangible performance improvements. Moreover, firm size and infrastructure readiness amplify the strength of these effects, indicating the importance of scalable technological frameworks. In contrast, smaller firms (e.g., Jaddo Sweilem) exhibited limited gains due to delayed decision-making, fragmented digital strategies, and insufficient resource allocation.

Discussion

The findings of this study demonstrate that the application of artificial intelligence (AI) plays a decisive role in improving digital administrative performance, particularly when guided by proactive and timely managerial involvement. The empirical evidence from the four Jordanian food manufacturing companies Siniora Food Industries, Kasih Food Manufacturing Group, Petra Juice Concentrates, and Jaddo Sweilem Factory confirmed that AI adoption had the strongest direct effect on administrative efficiency ($\beta = 0.321$, $p < 0.001$), followed by top management support ($\beta = 0.298$, $p < 0.001$) and the timing of managerial intervention ($\beta = 0.215$, $p < 0.01$). These results are consistent with previous research showing that AI integration enhances speed, accuracy, and data visibility across administrative processes. Aloqaily and Rawash (2022) found that AI applications in human-resource administration improved accuracy and responsiveness in Jordanian organizations, while Muñoz and Chimbo (2023) reported similar process optimization and strategic decision-making benefits in higher-education administration. The current study extends these conclusions to the industrial context, quantifying their effects within the food manufacturing sector and thereby filling a notable research gap in Arab industrial literature. In agreement with Alshehab (2025) and Ahmed et al. (2022), the present findings also highlight that technology alone is not sufficient; sustainable digital transformation depends on committed executive leadership that allocates resources, defines digital strategy, and communicates a clear vision. Companies where executives were actively involved in planning and monitoring AI projects such as Siniora achieved higher digital administrative performance than those with delayed or inconsistent leadership participation, echoing Corvalán's (2018) argument that early strategic engagement is critical for intelligent governance. Moreover, the moderating role of managerial timing observed here supports Iwadi, Ali, and Jabari (2024), who demonstrated that proactive leadership intervention strengthens job-performance outcomes in administrative offices. The mediation results further revealed that AI's impact is largely transmitted through process automation ($\beta = 0.137$, $p < 0.01$) and data-driven decision-making ($\beta = 0.184$, $p < 0.01$), showing that the value of AI arises from transforming workflows and institutionalizing analytical thinking rather than from simple digitization. These outcomes align with Abdulrazzaq (2025), who showed that digital applications improved administrative efficiency by automating reporting in the Iraqi Athletics Federation, and with Ufomba et al. (2024), who found that AI enhanced both administrative and learning efficiency through data-intensive management in Nigerian universities. Collectively, these studies and the present analysis affirm that AI's true performance benefits emerge when technological innovation is accompanied by leadership commitment, employee readiness, and data-based governance structures. The present findings also demonstrate context-specific differences: larger firms with established IT infrastructure (Siniora, Kasih) exhibit stronger AI–performance linkages ($R^2 = 0.72$ and 0.66 respectively), whereas smaller firms like Jaddo Sweilem lag behind due to limited resources and late leadership intervention, echoing Corvalán's (2018) caution that institutional capacity is fundamental for intelligent administration. Theoretically, these findings reinforce the Technology–Organization–Environment (TOE) framework and Dynamic Capabilities Theory by identifying managerial timing as a dynamic capability that enables organizations to sense opportunities early and integrate AI technologies effectively. In line with global evidence, this study concludes that AI adoption enhances administrative efficiency, but its success depends on how and when top management acts: early, strategic, and sustained engagement transforms digital investment into measurable organizational performance. In essence, leadership behavior particularly its timing serves as the missing bridge between technological capability and real administrative transformation, situating the Jordanian food industry within the broader international discourse on smart, data-driven, and human-centered digital administration.

Conclusion

The results of this study clearly demonstrate that artificial intelligence (AI) adoption has become a central enabler of digital administrative transformation in Jordan's food manufacturing sector, provided it is guided by proactive, well-timed, and sustained top management involvement. Using evidence from Siniora Food Industries, Kasih Food Manufacturing Group, Petra Juice Concentrates, and Jaddo Sweilem Factory, the study confirmed that

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AI tools significantly improve administrative efficiency, accuracy, and decision-making capacity, while leadership commitment and early managerial intervention amplify these effects. The statistical model explained 68.4% of the variance in digital administrative performance, confirming that technological investment alone cannot yield impact without executive vision and organizational readiness. Process automation and data-driven decision-making emerged as key mediating mechanisms translating AI integration into tangible performance gains, underscoring the importance of workflow redesign and analytical culture formation. These findings align with regional and global studies that position leadership timing and digital strategy as the true drivers of smart administrative systems. Theoretically, the research enriches the Technology–Organization–Environment (TOE) framework and Dynamic Capabilities Theory by identifying managerial timing as a strategic capability that determines transformation success. Practically, it provides a model for Jordanian and regional industrial leaders, emphasizing that early executive engagement, continuous support, and infrastructure investment are critical for achieving sustainable digital excellence. Ultimately, the study concludes that the synergy between AI innovation, leadership foresight, and organizational learning defines the future of administrative performance transforming Jordanian food manufacturing firms into more efficient, intelligent, and competitive enterprises in the era of digital economy and Vision 2030.

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