



Artificial Intelligence-Enabled Supply Chain Management and Competitive Advantage in the Electronics Industry

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Abstract

This study aimed to investigate the effect of artificial intelligence-enabled supply chain management and its dimensions on competitive advantage among electronics-industry firms in Tehran, Iran. This applied, quantitative, cross-sectional, and correlational study was conducted among managers, supervisors, specialists, and professional employees involved in supply chain-related activities in electronics firms in Tehran. A total of 312 valid questionnaires were analyzed. Artificial intelligence-enabled supply chain management was assessed through six dimensions: AI-enabled demand forecasting and planning, intelligent procurement and supplier management, AI-supported inventory management, intelligent production and operations planning, AI-enabled logistics and distribution, and supply chain information integration and decision support. Competitive advantage was measured across cost, quality, delivery and responsiveness, innovation, and flexibility dimensions. Data were analyzed using descriptive statistics and partial least squares structural equation modeling. Reliability and validity were assessed through factor loadings, Cronbach's alpha, composite reliability, average variance extracted, heterotrait-monotrait ratios, and variance inflation factors. Structural relationships were evaluated using bootstrapping with 5,000 resamples. Artificial intelligence-enabled supply chain management had a significant positive effect on competitive advantage ($\beta = 0.684$, $t = 16.683$, $p < 0.001$), explaining 46.8% of its variance ($R^2 = 0.468$; adjusted $R^2 = 0.466$). Predictive relevance was satisfactory ($Q^2 = 0.332$), and model fit was acceptable ($SRMR = 0.057$). Among the dimensions, supply chain information integration and decision support had the strongest effect on competitive advantage ($\beta = 0.224$, $p < 0.001$), followed by AI-supported inventory management ($\beta = 0.181$, $p = 0.001$), AI-enabled demand forecasting and planning ($\beta = 0.157$, $p = 0.003$), AI-enabled logistics and distribution ($\beta = 0.143$, $p = 0.005$), intelligent procurement and supplier management ($\beta = 0.126$, $p = 0.010$), and intelligent production and operations planning ($\beta = 0.119$, $p = 0.011$). The findings indicate that integrated application of artificial intelligence across supply chain functions can substantially strengthen competitive advantage in the electronics industry, particularly through improved information integration, decision support, inventory management, forecasting, and logistics capabilities.

Keywords: Artificial Intelligence; Supply Chain Management; Competitive Advantage; Electronics Industry; Supply Chain Integration; Digital Transformation

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1. Introduction

The increasing complexity, volatility, and technological intensity of contemporary supply chains have transformed supply chain management from a predominantly operational function into a strategic capability that directly affects organizational competitiveness. Firms are no longer evaluated solely according to their ability to procure materials, manage inventories, and deliver products at

acceptable costs; rather, they are expected to coordinate extensive networks of suppliers, production facilities, logistics providers, information systems, and customers while responding rapidly to market fluctuations and technological disruption. Supply chain integration has consequently become an important mechanism through which organizations can improve responsiveness, coordination, resource utilization, and long-term competitive positioning. Evidence from manufacturing



contexts indicates that stronger integration among supply chain partners can contribute to sustainable competitive advantage by reducing fragmentation and improving the synchronization of organizational activities [1]. Similarly, research on supply chain practices and dynamic capabilities suggests that organizations achieve superior performance when supply chain processes are combined with capabilities that enable sensing, adaptation, and reconfiguration in response to environmental changes [2]. These developments are particularly significant in industries characterized by rapid product obsolescence, short innovation cycles, extensive global sourcing, and high dependence on technological knowledge, among which the electronics industry represents one of the most prominent examples.

The electronics industry operates within supply networks that are highly sensitive to demand volatility, component shortages, technological change, geopolitical disturbances, transportation disruptions, and fluctuations in supplier capacity. Electronics firms often depend on globally dispersed suppliers for semiconductors, circuit components, specialized materials, software-enabled systems, and precision manufacturing services, making the coordination of information and physical flows particularly demanding. Traditional supply chain decision-making approaches based primarily on historical records, managerial intuition, and periodic planning may therefore be insufficient for environments in which conditions change rapidly and large volumes of heterogeneous data must be processed continuously. Research has shown that supply chain competitiveness increasingly depends on the ability to integrate technological upgrading, collaboration, and changing market demand into coordinated strategic responses [3]. Similarly, supply chain collaboration in advanced manufacturing has been associated with competitive advantage, relational quality, and the benefits generated through interorganizational cooperation [4]. These findings suggest that competitive performance in technology-intensive manufacturing depends not merely on possessing resources, but on converting information, relationships, and operational capabilities into timely and coordinated decisions.

Artificial intelligence has emerged as one of the most influential technological developments affecting this transformation. Within supply chain management, artificial intelligence refers broadly to the use of computational systems capable of learning from data, identifying patterns, generating predictions, optimizing decisions, automating selected activities, and supporting complex managerial

judgments. AI technologies can be applied to demand forecasting, procurement, supplier selection, inventory optimization, production scheduling, quality control, transportation planning, disruption prediction, customer demand analysis, and integrated decision support. The potential contribution of AI is therefore not limited to automation; it lies increasingly in augmenting the analytical and adaptive capabilities of supply chains. Research examining supply chain optimization has emphasized that AI can enhance forecasting accuracy, operational visibility, resource allocation, inventory management, and decision quality [5]. AI combined with big data analytics has also been proposed as an important means of addressing persistent supply chain problems through improved predictive capacity, process optimization, and operational efficiency [6]. From this perspective, AI-enabled supply chain management can be conceptualized as an organizational capability through which artificial intelligence is systematically integrated into interconnected supply chain processes rather than applied as an isolated technological tool.

One of the most important applications of AI in supply chain management concerns demand forecasting and planning. Conventional forecasting approaches may be limited when demand is affected by nonlinear relationships, rapid shifts in consumer preferences, seasonal variation, product substitution, and external shocks. AI-based predictive systems can integrate large volumes of historical, transactional, market, and operational data to identify patterns that may remain undetected through traditional analytical techniques. Predictive analytics has been increasingly associated with supply chain resilience because timely anticipation of disruption and demand variation allows firms to adjust sourcing, inventory, capacity, and logistics decisions proactively [7]. Deep learning applications similarly provide opportunities to model complex supply chain processes and generate data-driven managerial recommendations when relationships between variables are dynamic and difficult to represent through conventional models [8]. In the electronics industry, where product demand can shift rapidly because of innovation, technological substitution, and short product life cycles, improved forecasting can directly influence production efficiency, inventory availability, and responsiveness to customers.

Artificial intelligence may also improve procurement and supplier management by allowing firms to assess suppliers using broader sets of performance, risk, cost, delivery,

quality, and sustainability information. Supplier-related decisions are increasingly strategic because supply disruptions can propagate rapidly throughout interconnected production networks. Digital systems can assist organizations in continuously monitoring supplier performance, identifying risk patterns, evaluating alternative sourcing options, and supporting negotiation and procurement decisions. Supply chain finance research further demonstrates that interorganizational mechanisms can strengthen both supply-oriented and demand-oriented capabilities when firms manage partner relationships effectively [9]. Innovation capabilities also influence organizations' ability to adopt supply chain finance and related supply chain mechanisms by shaping organizational responsiveness to market demands [10]. These findings imply that intelligent procurement systems may contribute to competitive advantage not simply by reducing purchasing costs, but by improving the reliability, flexibility, and strategic quality of supplier relationships.

Inventory management represents another area in which AI can produce substantial operational value. Electronics companies frequently face a difficult balance between avoiding shortages of critical components and minimizing excessive stocks of products or components that may rapidly become obsolete. AI-supported inventory systems can analyze demand patterns, lead times, supplier reliability, production schedules, and inventory turnover to recommend more adaptive replenishment policies. Such capabilities can reduce uncertainty and enable organizations to allocate working capital more efficiently while maintaining required service levels. Lead-time management has been identified as a major determinant of supply chain performance in manufacturing because delays in material acquisition and delivery influence production continuity, responsiveness, and customer satisfaction [11]. The strategic importance of distribution capabilities similarly indicates that organizations require dynamic mechanisms for coordinating product availability and market delivery when competitive conditions change [12]. AI-enabled inventory and distribution decisions may therefore contribute simultaneously to cost efficiency, customer responsiveness, and operational flexibility.

Production and operations planning can likewise be strengthened through AI-supported decision systems. Electronics manufacturing often involves interdependent production stages, specialized machinery, uncertain component availability, variable order patterns, and stringent requirements for quality and delivery. Artificial

intelligence can assist in production scheduling, capacity allocation, bottleneck identification, predictive maintenance, and real-time adjustment of operational plans. These capabilities become particularly relevant as manufacturing moves toward digitally interconnected production and Industry 5.0 environments, where technological systems are expected to operate alongside human expertise, resilience, personalization, and sustainability considerations [13]. The growing strategic role of human competencies should therefore not be overlooked. Talent management remains essential to supply chain optimization because technological systems require employees capable of interpreting analytical outputs, managing complex networks, and translating technological possibilities into organizational decisions [14]. Even educational approaches to supply chain management increasingly emphasize interactive and digitally mediated learning as supply chain professionals must develop stronger analytical and collaborative capabilities [15]. Thus, AI adoption should be understood as a sociotechnical transformation in which technological capabilities and human expertise jointly shape supply chain performance.

The integration of artificial intelligence with digital supply chain technologies further expands its strategic potential. Technologies such as the Internet of Things, enterprise resource planning systems, cloud platforms, digital logistics systems, and connected e-commerce infrastructure generate large volumes of real-time information that can be analyzed through AI. The Internet of Things, for example, can improve organizational performance by strengthening supply chain integration and creating conditions through which firms achieve competitive advantage [16]. Electronic order processing systems likewise contribute to supply chain performance, while their effectiveness may depend on the integration provided by enterprise resource planning platforms [17]. In digital commerce environments, IoT-supported coordination mechanisms can improve the alignment of customer demand and enterprise supply chain activities through more responsive C2B processes [18]. Logistics 4.0 similarly demonstrates how digitally connected logistics technologies can increase sustainability and competitiveness by improving visibility, automation, and coordination across supply chain activities [19]. Consequently, AI may achieve its greatest value when embedded within an integrated digital architecture rather than introduced independently into isolated functional units.

Digital transformation also affects the strategic relationship between supply chain management and competitive advantage. Competitive advantage reflects an organization's ability to create and sustain superior value relative to competitors through combinations of cost efficiency, product and service quality, innovation, responsiveness, delivery performance, and flexibility. Digital technologies have been shown to strengthen firms' competitive advantage by improving supply chain performance, information availability, coordination, and decision-making quality [20]. Supply chain digitalization and resilience have similarly been linked with stronger competitiveness and organizational performance [21]. At the broader strategic level, effective supply chain management has been associated with improved competitiveness and organizational performance among small and medium-sized enterprises [22]. These findings indicate that supply chain capabilities constitute an important mechanism through which technological resources are converted into competitive outcomes.

Different dimensions of competitive advantage can potentially benefit from AI-enabled supply chains through distinct mechanisms. Cost advantage may arise from reduced inventory holding costs, lower procurement inefficiencies, optimized transportation, improved asset utilization, and fewer operational disruptions. Quality advantage can result from more accurate monitoring, defect prediction, supplier evaluation, and process control. Delivery and responsiveness advantages may emerge from improved demand prediction, dynamic scheduling, real-time logistics visibility, and accelerated decision-making. Innovation advantage may be strengthened when AI allows firms to detect changes in customer preferences, identify emerging supply opportunities, and coordinate new product introductions more effectively. Flexibility advantage, meanwhile, may depend on the ability to rapidly reconfigure sourcing, production, and distribution decisions when external conditions change. Research examining supply chain responsiveness confirms that supply chain management practices can contribute to competitive advantage by strengthening the responsiveness of the overall supply network [23]. Organizational supply chain agility and competitive capability are also influenced by organizational and environmental factors that determine the speed with which firms can respond to uncertainty [24]. In logistics contexts, outbound logistics strategies have similarly been shown to influence competitive advantage by affecting

delivery effectiveness, distribution efficiency, and customer service [25].

The strategic contribution of supply chain management increasingly extends to sustainability and resilience as well. Sustainable supply chain practices can improve business performance when environmental, operational, and strategic priorities are integrated throughout supply chain processes. Evidence from a major technology company indicates that sustainable supply chain management can contribute to business performance by strengthening the alignment between supply activities and broader organizational objectives [26]. Green supply chain practices and electronic supply chain capabilities have also been associated with competitive advantage, demonstrating that competitiveness can emerge from combining environmental considerations with digital supply chain processes [27]. Green logistics practices have similarly been examined as drivers of sustainable business performance, emphasizing that logistics decisions increasingly need to balance economic and sustainability outcomes [28]. In addition, sustainable supply chain management can serve as a mechanism connecting strategic and social resources with both financial and non-financial organizational outcomes [29]. These developments imply that AI-supported decision systems may contribute not only to short-term operational efficiency but also to broader strategic objectives related to resilience, environmental performance, and long-term competitiveness.

The relationship between supply chain configuration and competitive positioning is also evident in studies examining strategic alliances and network design. Green supply chain practices implemented within competitive strategic alliances can improve coordination and sustainability while supporting firms' strategic positioning [30]. Likewise, the location and design of competitive closed-loop supply chain facilities under uncertainty require integrated decisions that account for cost, competition, and network conditions [31]. Logistics outsourcing arrangements, including fourth-party logistics models, further demonstrate that specialized external coordination can influence the effectiveness of industrial logistics strategies when firms seek flexibility and access to advanced capabilities [32]. Such studies reinforce the view that competitive advantage depends increasingly on the architecture and intelligence of the entire supply network rather than the efficiency of individual firms considered in isolation.

Recent evidence further suggests that AI can directly enhance logistics and supply chain performance when its implementation is accompanied by complementary

organizational capabilities. Research in logistics firms indicates that artificial intelligence contributes to performance through mechanisms associated with supply chain consistency and logistics capabilities [33]. In other sectors, AI adoption has also been linked to broader dimensions of sustainable supply chain performance, demonstrating that intelligent systems can influence not only operational efficiency but also strategic and sustainability-related outcomes [34]. These findings are consistent with the broader argument that technology alone does not automatically produce competitive value. The outcomes of AI adoption depend on how extensively the technology is integrated into organizational routines, the quality of available data, the capability of employees to use analytical insights, the degree of supply chain integration, and the alignment between digital technologies and strategic priorities.

Despite the rapid expansion of research on digital supply chains, AI, logistics technologies, and competitive performance, several important gaps remain. First, much of the existing literature evaluates individual technologies or isolated supply chain functions, whereas AI-enabled supply chain management is inherently multidimensional and may simultaneously influence forecasting, procurement, inventory, production, logistics, and information integration. Second, studies frequently examine operational or supply chain performance as the principal outcome, while direct examination of multidimensional competitive advantage remains comparatively less developed. Third, findings from agriculture, automotive manufacturing, healthcare, logistics, SMEs, and other sectors cannot automatically be generalized to electronics firms because electronics supply chains exhibit distinct technological characteristics, short product cycles, complex component dependencies, and high exposure to innovation-driven uncertainty. Fourth, emerging digital supply chain research emphasizes integration, responsiveness, resilience, and sustainability, yet empirical evidence remains limited regarding the relative contribution of different AI-enabled supply chain dimensions to competitive advantage. Finally, the organizational context of developing and emerging economies warrants further investigation because differences in technological infrastructure, supply chain maturity, access to digital expertise, investment capacity, and market conditions may shape the returns generated by AI adoption.

These gaps are particularly relevant to electronics firms operating in Tehran, where organizations compete within an environment characterized by technological change, supply

uncertainty, evolving customer expectations, and the need to improve operational efficiency while maintaining responsiveness and innovation. For such firms, artificial intelligence may offer substantial strategic value, but this value depends on whether AI is effectively embedded across supply chain functions rather than adopted symbolically or in fragmented applications. Understanding how AI-supported forecasting, procurement, inventory management, production planning, logistics, and information integration contribute to competitive advantage can therefore provide both theoretical and managerial insight. Such an approach also extends previous research on Logistics 4.0, digital technologies, supply chain integration, sustainable supply chains, and organizational capabilities by positioning AI-enabled supply chain management as an integrated strategic capability through which firms may develop stronger cost, quality, responsiveness, innovation, and flexibility advantages [35].

Accordingly, the aim of this study was to investigate the effect of artificial intelligence-enabled supply chain management and its dimensions on competitive advantage among electronics-industry firms in Tehran, Iran.

2. Methodology

This study employed a quantitative, applied, cross-sectional, and correlational research design to investigate the relationship between artificial intelligence-enabled supply chain management and competitive advantage in the electronics industry. The statistical population consisted of managers, supervisors, supply chain specialists, procurement and purchasing personnel, logistics and distribution experts, production and operations managers, information technology specialists, and other professional employees directly involved in supply chain-related activities in electronics manufacturing and distribution companies located in Tehran, Iran. Particular attention was given to respondents whose organizational responsibilities provided them with sufficient knowledge of their firms' procurement, inventory management, demand forecasting, production planning, logistics, supplier relationships, information systems, and competitive practices. A multistage sampling procedure was employed. First, electronics manufacturing, assembly, distribution, and technology-oriented firms operating in Tehran were identified as the organizational sampling units. Subsequently, organizations were selected from different areas of Tehran to provide greater representation of the local

electronics industry, and eligible employees within the participating companies were recruited using proportionate stratified sampling according to their functional areas. A total of 340 questionnaires were distributed. After excluding questionnaires with substantial missing information, patterned responses, and incomplete demographic or measurement data, 312 valid questionnaires were retained for statistical analysis, corresponding to a usable response rate of 91.8%. Thus, the final sample consisted of 312 participants. The inclusion criteria were current employment in an electronics-sector organization located in Tehran, involvement in or sufficient familiarity with supply chain, logistics, procurement, production, information technology, or strategic management activities, at least one year of organizational work experience, and willingness to participate in the study. Individuals who did not have sufficient familiarity with organizational supply chain processes or returned substantially incomplete questionnaires were excluded. Participants were informed that participation was voluntary, that their responses would remain confidential and would be analyzed only in aggregate form, and that they could discontinue participation at any stage without consequence. No personally identifying information was included in the analytical dataset.

Data were collected using a structured self-administered questionnaire consisting of three sections: demographic and professional characteristics, artificial intelligence-enabled supply chain management, and competitive advantage. The demographic section obtained information on respondents' gender, age, educational attainment, organizational position, years of professional experience, organizational tenure, functional area, and characteristics of the employing company. Artificial intelligence-enabled supply chain management was operationalized as the extent to which artificial intelligence technologies were integrated into major supply chain processes and used to improve the quality, speed, intelligence, and coordination of supply chain decisions. The measurement items were developed through adaptation and integration of established constructs used in the literature on artificial intelligence capability, digital supply chain management, supply chain analytics, and intelligent decision support. The resulting instrument comprised 24 items organized into six dimensions: AI-enabled demand forecasting and planning, intelligent procurement and supplier management, AI-supported inventory management, intelligent production and operations planning, AI-enabled logistics and distribution, and supply chain information integration and decision

support. Each dimension consisted of four items. Respondents indicated the extent to which each statement characterized their organization using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores indicated greater deployment and integration of artificial intelligence in supply chain management. Examples of the operational content measured by the questionnaire included the use of artificial intelligence for demand prediction, supplier evaluation, procurement decisions, inventory optimization, production scheduling, identification of supply chain disruptions, logistics planning, real-time analysis of operational information, and automated or data-driven decision support. Prior to the main data collection, the questionnaire was reviewed by a panel of university faculty members and industry specialists in supply chain management, operations management, artificial intelligence, and information systems to assess the clarity, relevance, and comprehensiveness of the items. A pilot administration was subsequently conducted with 30 professionals from the target sector who were not included in the final sample, and minor wording modifications were made to improve clarity and contextual relevance.

Competitive advantage was measured using a multidimensional questionnaire based on established strategic management and supply chain performance measures. Competitive advantage was defined as an organization's ability to achieve a superior market position relative to its major competitors by creating greater customer value, controlling costs, improving quality, responding rapidly to changes, introducing innovations, and maintaining operational flexibility. The scale consisted of 20 items distributed across five dimensions: cost advantage, quality advantage, delivery and responsiveness advantage, innovation advantage, and flexibility advantage, with four items assigned to each dimension. Participants evaluated their organizations relative to major competitors using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The items assessed capabilities such as achieving lower operating and supply chain costs, maintaining consistent product quality, meeting customer requirements rapidly, reducing order and delivery lead times, introducing new or improved products, responding to technological and market changes, and adapting production and supply chain operations to fluctuations in customer demand. Higher overall scores represented stronger perceived competitive advantage. Content and face validity of this section were evaluated by the same academic and industry expert panel. Construct validity of both principal

instruments was subsequently evaluated using confirmatory factor analysis. Internal consistency reliability was examined using Cronbach's alpha and composite reliability, with coefficients of 0.70 or higher considered acceptable. Convergent validity was evaluated through standardized factor loadings and average variance extracted, with an average variance extracted value of at least 0.50 regarded as evidence of adequate convergence. Discriminant validity was examined using the heterotrait-monotrait ratio of correlations, and values below the recommended threshold were interpreted as supporting the empirical distinctiveness of the study constructs.

Data analysis was conducted through descriptive and inferential statistical procedures. Before hypothesis testing, the dataset was screened for completeness, invalid responses, outliers, and potential data-entry errors. Descriptive statistics, including frequency, percentage, mean, standard deviation, minimum, maximum, skewness, and kurtosis, were calculated to characterize the participants and summarize the distribution of the principal study variables. The measurement model was assessed before evaluation of the structural relationships. Indicator reliability was examined using standardized outer loadings, while internal consistency reliability was assessed using Cronbach's alpha and composite reliability. Convergent validity was evaluated on the basis of average variance extracted, and discriminant validity was assessed using the heterotrait-monotrait ratio. Potential multicollinearity among predictor constructs was examined through variance inflation factor values. After establishing the adequacy of the measurement model, structural equation modeling using the partial least squares approach was employed to test the hypothesized effects of artificial intelligence-enabled supply chain management on competitive advantage. The explanatory power of the structural model was assessed using the coefficient of determination (R^2), while predictive relevance was examined using the Q^2 statistic. Effect sizes were evaluated using f^2 values to determine the magnitude of the contribution of artificial intelligence-enabled supply chain management to the explained variance in competitive advantage. The statistical significance of structural path coefficients was determined through a nonparametric bootstrapping procedure with 5,000 resamples, and standardized path coefficients, t values, and p values were

reported. Model fit was additionally assessed using the standardized root mean square residual, with values below 0.08 considered indicative of acceptable model fit. All hypothesis tests were two-tailed, and a significance level of $p < .05$ was adopted. Preliminary data management and descriptive analyses were performed using IBM SPSS, while measurement and structural model analyses were conducted using SmartPLS.

3. Findings and Results

A total of 312 valid questionnaires were included in the final analysis. Of the respondents, 204 (65.4%) were male and 108 (34.6%) were female. Regarding age, 48 participants (15.4%) were younger than 30 years, 112 (35.9%) were between 30 and 39 years, 96 (30.8%) were between 40 and 49 years, and 56 (17.9%) were aged 50 years or older. In terms of educational attainment, 24 respondents (7.7%) held an associate degree or lower, 136 (43.6%) held a bachelor's degree, 119 (38.1%) held a master's degree, and 33 (10.6%) held a doctoral degree. With respect to organizational experience, 49 respondents (15.7%) had fewer than 5 years of professional experience, 81 (26.0%) had between 5 and 10 years, 116 (37.2%) had between 11 and 20 years, and 66 (21.2%) reported more than 20 years of experience. Based on organizational position, 47 participants (15.1%) were senior or executive managers, 72 (23.1%) were middle-level managers, 83 (26.6%) were supervisors or unit heads, and 110 (35.3%) were specialists or professional staff. In terms of functional area, 73 respondents (23.4%) worked primarily in procurement and supplier management, 62 (19.9%) in production and operations, 58 (18.6%) in logistics and distribution, 51 (16.3%) in information technology and digital systems, 41 (13.1%) in inventory and planning functions, and 27 (8.7%) in strategic management or other supply chain-related activities. The demographic profile therefore indicated that the study sample was composed predominantly of experienced and highly educated professionals with direct exposure to supply chain and organizational decision-making processes in the electronics industry, providing an appropriate empirical basis for examining artificial intelligence-enabled supply chain management and competitive advantage.

Table 1. Descriptive Statistics for the Main Study Variables

Variable	Number of Items	Minimum	Maximum	Mean	Standard Deviation	Skewness	Kurtosis
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AI-Enabled Demand Forecasting and Planning	4	1.50	5.00	3.74	0.67	-0.48	0.31
Intelligent Procurement and Supplier Management	4	1.25	5.00	3.61	0.72	-0.36	0.18
AI-Supported Inventory Management	4	1.50	5.00	3.69	0.69	-0.41	0.27
Intelligent Production and Operations Planning	4	1.25	5.00	3.57	0.74	-0.29	-0.12
AI-Enabled Logistics and Distribution	4	1.25	5.00	3.52	0.76	-0.24	-0.19
Supply Chain Information Integration and Decision Support	4	1.50	5.00	3.79	0.65	-0.53	0.42
Artificial Intelligence-Enabled Supply Chain Management	24	1.67	4.96	3.65	0.61	-0.44	0.35
Cost Advantage	4	1.50	5.00	3.58	0.68	-0.32	0.21
Quality Advantage	4	1.75	5.00	3.76	0.64	-0.47	0.39
Delivery and Responsiveness Advantage	4	1.50	5.00	3.71	0.66	-0.43	0.30
Innovation Advantage	4	1.25	5.00	3.82	0.70	-0.51	0.24
Flexibility Advantage	4	1.50	5.00	3.68	0.67	-0.37	0.16
Competitive Advantage	20	1.70	4.95	3.71	0.59	-0.46	0.37

As shown in Table 1, the mean values of all study dimensions were above the theoretical midpoint of 3.00, indicating that respondents generally perceived both artificial intelligence integration in supply chain activities and organizational competitive advantage to be at moderate-to-high levels. Among the dimensions of artificial intelligence-enabled supply chain management, supply chain information integration and decision support obtained the highest mean score ($M = 3.79$, $SD = 0.65$), followed by AI-enabled demand forecasting and planning ($M = 3.74$, $SD = 0.67$) and AI-supported inventory management ($M = 3.69$, $SD = 0.69$). These results suggest that participating electronics firms had made greater progress in using artificial intelligence for information processing, analytical decision support, demand estimation, and inventory-related decisions than in other areas. AI-enabled logistics and distribution had the lowest mean among the supply chain dimensions ($M = 3.52$, $SD = 0.76$), although its score

remained clearly above the midpoint of the measurement scale. The overall mean for artificial intelligence-enabled supply chain management was 3.65 ($SD = 0.61$), indicating a relatively favorable level of AI adoption across supply chain functions. Regarding competitive advantage, innovation advantage recorded the highest mean ($M = 3.82$, $SD = 0.70$), followed by quality advantage ($M = 3.76$, $SD = 0.64$), whereas cost advantage showed the lowest mean ($M = 3.58$, $SD = 0.68$). The overall competitive advantage score was 3.71 ($SD = 0.59$). In addition, the skewness statistics ranged from -0.53 to -0.24 and the kurtosis statistics ranged from -0.19 to 0.42, remaining well within conventional acceptable limits. Therefore, no serious departure from univariate normality was evident in the distributions of the main study variables, although partial least squares structural equation modeling does not require strict multivariate normality.

Table 2. Measurement Model Reliability and Convergent Validity

Construct	Standardized Loading Range	Cronbach's Alpha	Composite Reliability	AVE	VIF Range
AI-Enabled Demand Forecasting and Planning	0.741–0.864	0.842	0.894	0.679	1.48–2.13
Intelligent Procurement and Supplier Management	0.728–0.853	0.824	0.883	0.654	1.39–2.06
AI-Supported Inventory Management	0.752–0.879	0.857	0.903	0.701	1.52–2.24
Intelligent Production and Operations Planning	0.716–0.846	0.811	0.875	0.637	1.41–2.18
AI-Enabled Logistics and Distribution	0.708–0.841	0.803	0.868	0.622	1.36–2.11
Supply Chain Information Integration and Decision Support	0.768–0.892	0.872	0.913	0.724	1.63–2.37
Artificial Intelligence-Enabled Supply Chain Management	0.761–0.891	0.918	0.936	0.709	1.71–2.66
Cost Advantage	0.731–0.855	0.826	0.884	0.656	1.32–1.91
Quality Advantage	0.759–0.874	0.851	0.899	0.691	1.46–2.03
Delivery and Responsiveness Advantage	0.744–0.867	0.839	0.892	0.675	1.43–1.98
Innovation Advantage	0.773–0.895	0.879	0.917	0.735	1.57–2.21
Flexibility Advantage	0.748–0.869	0.846	0.896	0.683	1.49–2.09

Competitive Advantage	0.775–0.902	0.926	0.943	0.731	1.76–2.58
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The results of the measurement model assessment are reported in Table 2. All standardized indicator loadings exceeded the minimum recommended threshold of 0.70. Across the dimensions, factor loadings ranged from 0.708 to 0.902, indicating that all retained indicators exhibited satisfactory relationships with their corresponding latent constructs. The internal consistency of the measurement model was also acceptable. Cronbach's alpha coefficients ranged from 0.803 for AI-enabled logistics and distribution to 0.926 for competitive advantage, while composite reliability values ranged from 0.868 to 0.943. Because all Cronbach's alpha and composite reliability values exceeded the conventional criterion of 0.70, the results demonstrated adequate to excellent reliability for all study constructs. Convergent validity was supported because the average variance extracted values ranged from 0.622 to 0.735, exceeding the recommended minimum value of 0.50 in

every case. The higher-order artificial intelligence-enabled supply chain management construct demonstrated strong internal consistency, with Cronbach's alpha of 0.918, composite reliability of 0.936, and AVE of 0.709. Similarly, competitive advantage demonstrated Cronbach's alpha of 0.926, composite reliability of 0.943, and AVE of 0.731. These values indicate that the indicators shared a substantial proportion of variance with their underlying latent constructs. Furthermore, variance inflation factor values ranged from 1.32 to 2.66, remaining substantially below the threshold of 5.00. Thus, no problematic multicollinearity was identified among the indicators or predictor constructs. Taken together, these findings confirmed satisfactory indicator reliability, internal consistency reliability, convergent validity, and absence of serious collinearity within the proposed measurement model.

Table 3. Discriminant Validity Based on the Heterotrait-Monotrait Ratio

Construct	AIDF	IPSM	AIIM	IPO	AILD	SCI	CA	QA	DRA	IA	FA
AIDF	—										
IPSM	0.681	—									
AIIM	0.714	0.669	—								
IPO	0.646	0.702	0.691	—							
AILD	0.611	0.685	0.658	0.721	—						
SCI	0.748	0.704	0.732	0.689	0.674	—					
CA	0.493	0.521	0.548	0.504	0.487	0.557	—				
QA	0.529	0.546	0.573	0.538	0.514	0.596	0.672	—			
DRA	0.584	0.569	0.611	0.593	0.626	0.637	0.648	0.701	—		
IA	0.613	0.578	0.625	0.604	0.591	0.668	0.619	0.684	0.716	—	
FA	0.562	0.551	0.587	0.609	0.644	0.621	0.638	0.693	0.739	0.728	—

Note. AIDF = AI-Enabled Demand Forecasting and Planning; IPSM = Intelligent Procurement and Supplier Management; AIIM = AI-Supported Inventory Management; IPO = Intelligent Production and Operations Planning; AILD = AI-Enabled Logistics and Distribution; SCI = Supply Chain Information Integration and Decision Support; CA = Cost Advantage; QA = Quality Advantage; DRA = Delivery and Responsiveness Advantage; IA = Innovation Advantage; FA = Flexibility Advantage.

Table 3 presents the results of the discriminant validity analysis based on the heterotrait-monotrait ratio of correlations. The HTMT values ranged from 0.487 to 0.748, and all values remained below the conservative threshold of 0.85. The highest HTMT coefficient was observed between AI-enabled demand forecasting and planning and supply chain information integration and decision support (HTMT = 0.748), followed by delivery and responsiveness advantage and flexibility advantage (HTMT = 0.739), while the lowest coefficient occurred between AI-enabled logistics and distribution and cost advantage (HTMT = 0.487). Although several constructs were moderately associated, none of the pairwise HTMT values approached levels that

would indicate a lack of empirical distinctiveness. This result was particularly important because several dimensions of AI-enabled supply chain management conceptually represent related organizational capabilities. Nevertheless, the values showed that demand forecasting, supplier management, inventory management, production planning, logistics, and information integration captured distinguishable aspects of AI-enabled supply chain activity. Similarly, cost, quality, responsiveness, innovation, and flexibility remained distinguishable manifestations of competitive advantage. Therefore, the discriminant validity criterion was satisfied for the measurement model,

supporting subsequent estimation and interpretation of the structural relationships.

Table 4. Structural Model Results and Hypothesis Testing

Structural Relationship	β	Standard Error	t	p	f^2	Decision
AI-Enabled Supply Chain Management $\rightarrow$ Competitive Advantage	0.684	0.041	16.683	<0.001	0.883	Supported
AI-Enabled Demand Forecasting and Planning $\rightarrow$ Competitive Advantage	0.157	0.052	3.019	0.003	0.041	Significant
Intelligent Procurement and Supplier Management $\rightarrow$ Competitive Advantage	0.126	0.049	2.571	0.010	0.028	Significant
AI-Supported Inventory Management $\rightarrow$ Competitive Advantage	0.181	0.055	3.291	0.001	0.051	Significant
Intelligent Production and Operations Planning $\rightarrow$ Competitive Advantage	0.119	0.047	2.532	0.011	0.026	Significant
AI-Enabled Logistics and Distribution $\rightarrow$ Competitive Advantage	0.143	0.051	2.804	0.005	0.036	Significant
Supply Chain Information Integration and Decision Support $\rightarrow$ Competitive Advantage	0.224	0.057	3.930	<0.001	0.077	Significant
Structural Model Indicator	Value					
R ² for Competitive Advantage	0.468					
Adjusted R ²	0.466					
Q ² for Competitive Advantage	0.332					
SRMR	0.057					

As indicated in Table 4, artificial intelligence-enabled supply chain management had a positive and statistically significant effect on competitive advantage ($\beta = 0.684$, $t = 16.683$, $p < 0.001$). The standardized path coefficient demonstrates a strong positive relationship, indicating that organizations with higher levels of artificial intelligence integration throughout their supply chain activities tended to report substantially stronger competitive advantage. The corresponding effect size was $f^2 = 0.883$, which represents a large effect and confirms that AI-enabled supply chain management made a substantial contribution to explaining variations in competitive advantage. The coefficient of determination for competitive advantage was $R^2 = 0.468$, with an adjusted R^2 of 0.466, demonstrating that approximately 46.8% of the variance in competitive advantage was explained by the AI-enabled supply chain management construct. This represents moderate-to-substantial explanatory power in the context of organizational and strategic management research. Predictive relevance was also confirmed by the Q^2 value of 0.332, which was greater than zero and indicated that the model possessed meaningful out-of-sample predictive relevance for competitive advantage. Furthermore, the SRMR value was 0.057, which was lower than the recommended maximum value of 0.08 and therefore indicated satisfactory overall model fit.

Examination of the individual dimensions of artificial intelligence-enabled supply chain management provided additional insight into the sources of competitive advantage. Supply chain information integration and decision support demonstrated the strongest individual relationship with

competitive advantage ($\beta = 0.224$, $t = 3.930$, $p < 0.001$, $f^2 = 0.077$). This finding indicates that the organizational capability to integrate data from multiple supply chain functions and use AI-supported analytics in decision-making was the most influential individual AI-related capability in predicting competitive advantage. AI-supported inventory management had the second strongest standardized effect ($\beta = 0.181$, $t = 3.291$, $p = 0.001$, $f^2 = 0.051$), indicating that improvements in inventory optimization, stock-level prediction, replenishment decisions, and management of inventory-related uncertainty were associated with stronger competitive positioning. AI-enabled demand forecasting and planning also exerted a statistically significant positive effect ($\beta = 0.157$, $t = 3.019$, $p = 0.003$, $f^2 = 0.041$), suggesting that more accurate forecasting and planning supported firms' ability to align resources with demand and respond effectively to market fluctuations. AI-enabled logistics and distribution showed a positive significant effect ($\beta = 0.143$, $t = 2.804$, $p = 0.005$, $f^2 = 0.036$), while intelligent procurement and supplier management was also positively associated with competitive advantage ($\beta = 0.126$, $t = 2.571$, $p = 0.010$, $f^2 = 0.028$). Intelligent production and operations planning produced the smallest, although still statistically significant, individual effect ($\beta = 0.119$, $t = 2.532$, $p = 0.011$, $f^2 = 0.026$). Therefore, all six dimensions contributed positively to competitive advantage, but the magnitude of their effects differed. Overall, the results demonstrate that the value of artificial intelligence in the electronics industry is not limited to one isolated supply chain activity; rather, competitive benefits emerge from its coordinated application across forecasting, procurement, inventory,

production, logistics, and integrated information-based decision-making.

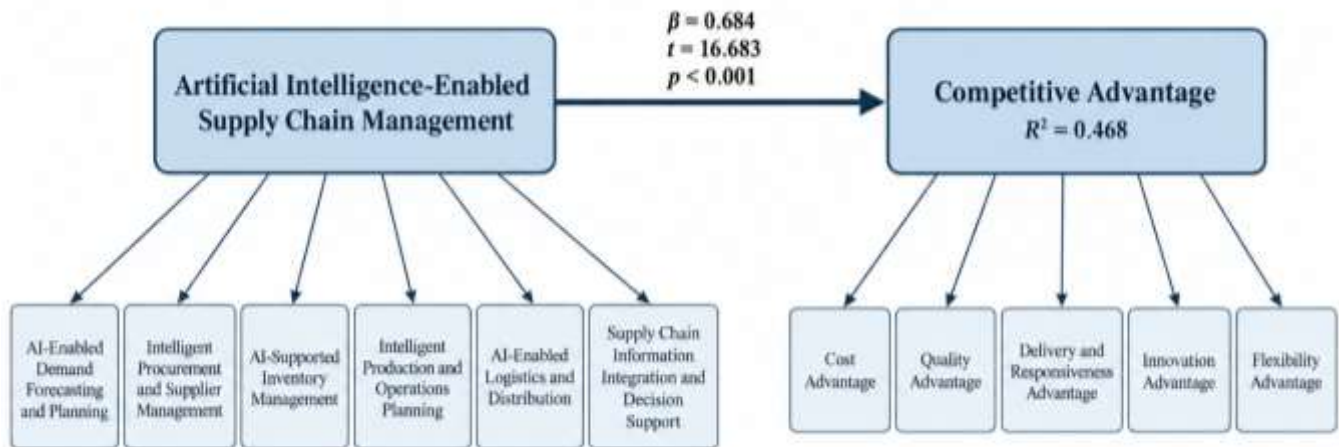


Figure 1. Structural Model of the Effect of Artificial Intelligence-Enabled Supply Chain Management on Competitive Advantage in the Electronics Industry

4. Discussion and Conclusion

The present study examined the effect of artificial intelligence-enabled supply chain management on competitive advantage in the electronics industry and showed that AI-enabled supply chain management had a strong, positive, and statistically significant effect on competitive advantage. The structural model indicated that AI-enabled supply chain management explained a substantial proportion of variance in competitive advantage, with a standardized path coefficient of $\beta = 0.684$, $t = 16.683$, and $p < 0.001$, while the R^2 value of 0.468 demonstrated that approximately 46.8% of the variance in competitive advantage was accounted for by the model. The predictive relevance statistic was also satisfactory, with $Q^2 = 0.332$, and the SRMR value of 0.057 supported adequate model fit. Taken together, these findings indicate that the integration of artificial intelligence across supply chain activities is not merely an operational improvement but a strategically important capability associated with stronger competitive positioning. This result is consistent with prior research emphasizing that supply chain integration, digitalization, and advanced analytical capabilities can generate sustainable forms of competitive advantage by improving coordination, responsiveness, and the quality of managerial decision-making [1, 20, 21]. The result is also aligned with evidence that effective supply chain practices enhance organizational performance when they are combined with

dynamic capabilities that allow firms to sense environmental changes and reconfigure resources in response to them [2].

The strong overall effect of AI-enabled supply chain management on competitive advantage can be explained by the particular conditions of the electronics industry, where short product life cycles, technological complexity, rapid innovation, component dependency, demand volatility, and the possibility of supply disruption make speed and analytical accuracy especially important. Under such conditions, firms that use AI to improve forecasting, inventory management, supplier evaluation, production planning, logistics, and information integration are better positioned to reduce uncertainty and respond more rapidly to market and operational changes. This interpretation is supported by studies showing that AI and big data analytics can improve supply chain efficiency by strengthening predictive capacity and optimization across interconnected processes [6]. Similarly, AI-based supply chain optimization has been linked to improved decision-making, planning accuracy, and resource utilization [5]. The result is also consistent with research demonstrating that artificial intelligence can enhance logistics firm performance when it is embedded in broader supply chain consistency and logistics capabilities [33]. Therefore, the findings of the present study suggest that competitive advantage arises not from AI adoption in isolation, but from the systematic incorporation of AI into interdependent supply chain processes.

Among the dimensions examined, supply chain information integration and decision support produced the strongest individual effect on competitive advantage, with $\beta = 0.224$, $t = 3.930$, and $p < 0.001$. This finding indicates that the ability to combine data from different supply chain functions and transform these data into timely, AI-supported decisions is especially important for competitive performance. This result can be explained by the fact that electronics supply chains generate large volumes of heterogeneous information concerning suppliers, customer demand, inventory, production schedules, logistics, and market changes. When these data remain fragmented, managerial decisions are likely to be slower and less accurate; when they are integrated, organizations can obtain more comprehensive visibility and coordinate decisions across functions. Previous research has similarly shown that the integration of digital technologies within supply chains can enhance competitive advantage through improved information flow, coordination, and supply chain performance [20]. The role of Internet of Things adoption in strengthening organizational performance through supply chain integration also supports this interpretation [16]. Furthermore, enterprise resource planning systems have been shown to strengthen the relationship between electronic processing systems and supply chain performance, underscoring the importance of integrated information infrastructure [17]. The strong effect observed in the present study therefore suggests that AI is most valuable when embedded in an integrated information environment capable of supporting coordinated decisions across the supply network.

AI-supported inventory management had the second strongest effect on competitive advantage, with $\beta = 0.181$, $t = 3.291$, and $p = 0.001$. This finding indicates that the intelligent management of inventory levels, replenishment timing, stock availability, and component requirements contributes meaningfully to competitive performance. The electronics industry is particularly vulnerable to inventory-related inefficiencies because excessive inventory can rapidly lose value as technologies become obsolete, while insufficient inventory can interrupt production and delay delivery. AI systems can reduce this tension by improving demand prediction, identifying consumption patterns, and optimizing replenishment decisions. The observed finding is compatible with the broader literature showing that predictive analytics improves resilience and helps supply chains anticipate disruptions and demand changes [7]. Deep learning approaches have also been shown to provide useful

managerial support for optimizing supply chain processes characterized by complexity and nonlinear relationships [8]. In addition, research on lead-time management demonstrates that effective control over timing and material availability is closely associated with manufacturing supply chain performance [11]. Thus, AI-supported inventory management can strengthen competitive advantage by simultaneously reducing waste, improving product availability, protecting working capital, and supporting more reliable customer service.

AI-enabled demand forecasting and planning also had a significant positive effect on competitive advantage, with $\beta = 0.157$, $t = 3.019$, and $p = 0.003$. This result indicates that electronics firms benefit competitively when AI is used to anticipate demand patterns and improve planning decisions. Demand in the electronics industry may fluctuate sharply as a result of innovation, customer preferences, competitive product launches, seasonality, and changes in technology. More accurate forecasts can therefore help organizations align procurement, production, inventory, and distribution decisions with expected market conditions. This interpretation is supported by research emphasizing the strategic role of predictive analytics in improving supply chain resilience and preparing firms for changes in demand and operational conditions [7]. The result is also consistent with studies indicating that technological upgrading and improved supply chain collaboration enhance competitiveness when firms are able to align their operational activities with market demand [3]. In addition, customer-to-business coordination through Internet of Things-supported systems has been shown to improve supply chain responsiveness in digitally connected environments [18]. These findings collectively reinforce the idea that AI-based forecasting contributes to competitive advantage by enabling firms to act proactively rather than reactively.

AI-enabled logistics and distribution also significantly predicted competitive advantage, with $\beta = 0.143$, $t = 2.804$, and $p = 0.005$. This result suggests that intelligent logistics systems contribute to competitive advantage by improving transportation planning, delivery coordination, route optimization, tracking, and responsiveness. In competitive markets, logistics performance directly influences customer satisfaction, order fulfillment, lead times, and distribution costs. Previous research has demonstrated that outbound logistics strategies can shape competitive advantage by improving distribution effectiveness and customer service [25]. The importance of Logistics 4.0 in strengthening

competitiveness has likewise been emphasized in studies showing that digital logistics technologies improve visibility, automation, and coordination [19, 35]. Dynamic distribution capabilities have also been linked to stronger supply chain performance, especially when organizations must adapt distribution systems to changing market requirements [12]. Therefore, the present finding indicates that AI-enabled logistics capabilities can transform distribution from a support activity into a source of strategic advantage, particularly when speed and reliability are central to customer expectations.

Intelligent procurement and supplier management produced a positive and significant effect on competitive advantage, with $\beta = 0.126$, $t = 2.571$, and $p = 0.010$. Although this effect was smaller than those of information integration, inventory management, and demand forecasting, it nevertheless confirms that AI-supported supplier evaluation, purchasing decisions, sourcing strategies, and supplier risk management contribute to competitive outcomes. Electronics firms often depend on specialized suppliers for critical components, and disruptions in supplier performance may have cascading effects throughout production and distribution. AI can assist firms in comparing suppliers, evaluating delivery reliability, anticipating risk, and optimizing procurement decisions. This interpretation aligns with previous evidence that supply chain collaboration and interorganizational relationships can influence competitive advantage and benefits within advanced manufacturing environments [4]. Supply chain finance and partner-related capabilities have likewise been shown to improve both supply- and demand-oriented performance when interorganizational relationships are effectively managed [9]. Research on strategic alliances also supports the strategic significance of supplier and partner relationships in strengthening supply chain performance and competitive position [30]. Hence, intelligent supplier management can strengthen competitiveness by reducing sourcing uncertainty, improving quality, and supporting more stable and adaptive supply networks.

Intelligent production and operations planning had the smallest significant individual effect on competitive advantage, with $\beta = 0.119$, $t = 2.532$, and $p = 0.011$. Although comparatively weaker, this finding still indicates that AI-supported scheduling, capacity planning, process optimization, and operational decision-making contribute positively to competitive performance. One explanation for the smaller effect may be that the benefits of intelligent production planning are partly transmitted through other

functions such as inventory management, demand forecasting, and logistics. In other words, production planning may create competitive value most effectively when it is synchronized with upstream and downstream supply chain activities rather than operated independently. This interpretation is consistent with the dynamic capability perspective, which emphasizes that performance depends on the coordinated reconfiguration of organizational resources rather than isolated functional improvements [2]. The growing importance of Industry 5.0 further supports this view, as advanced manufacturing increasingly requires interaction among automation, human judgment, resilience, and interconnected supply chain systems [13]. Accordingly, AI-supported production planning should be viewed as one component of a broader integrated capability rather than as a standalone source of competitive advantage.

The descriptive findings also showed relatively favorable levels of both AI-enabled supply chain management and competitive advantage among the participating firms. Supply chain information integration and decision support had the highest mean among the AI-related dimensions, while innovation advantage showed the highest mean among competitive advantage dimensions. These patterns are conceptually consistent. Firms that are better able to integrate data and use intelligent decision support may also be better positioned to identify new opportunities, detect changes in demand, accelerate product development, and coordinate innovation activities. Research on digital technologies has similarly shown that digitalization can create competitive benefits by improving both supply chain performance and organizational responsiveness [20]. Studies of supply chain digitalization have also linked technological integration with resilience, competitiveness, and firm performance [21]. The prominence of innovation advantage in the present study is therefore particularly important for electronics firms, because their long-term competitiveness often depends on continuous technological renewal and the ability to introduce products and solutions faster than competitors.

The findings further suggest that the competitive effects of AI-enabled supply chain management are multidimensional. Competitive advantage in the present study included cost, quality, delivery and responsiveness, innovation, and flexibility, and the strong overall structural relationship indicates that AI-enabled supply chain management may contribute to all of these dimensions simultaneously. Reduced procurement inefficiencies, more accurate inventory decisions, optimized logistics, and

improved capacity utilization can support cost advantage, whereas better supplier selection, process monitoring, and information quality can strengthen quality advantage. Improved forecasting and real-time logistics coordination can increase delivery speed and responsiveness, while integrated data and advanced analytics can support innovation and flexibility. This interpretation is compatible with evidence that supply chain responsiveness serves as an important mechanism linking supply chain practices to competitive advantage [23]. It also aligns with research demonstrating that supply chain agility contributes to competitive capability under dynamic market conditions [24]. Therefore, the value of AI should not be evaluated solely in terms of cost reduction; its more important strategic contribution may be its capacity to strengthen multiple competitive dimensions at the same time.

The results are also consistent with research highlighting the broader strategic importance of digital and sustainable supply chain transformation. Green and electronic supply chain practices have been associated with stronger competitive advantage [27], while sustainable supply chain management has been linked to improved business performance in technology-intensive organizations [26]. Green logistics has likewise been shown to contribute to sustainable business performance [28], and sustainable supply chain mechanisms can connect strategic capabilities with both financial and non-financial outcomes [29]. These studies suggest that digital supply chain capabilities increasingly overlap with resilience and sustainability objectives. AI may therefore support competitive advantage not only through immediate improvements in efficiency, but also by enabling more adaptive, resilient, and sustainable supply chain configurations over time.

Another important implication of the results concerns the role of complementary organizational capabilities. The findings demonstrate strong associations between AI-enabled supply chain practices and competitive advantage, but they should not be interpreted as suggesting that technology alone creates performance gains automatically. Effective AI deployment requires appropriate data infrastructure, organizational integration, employee expertise, managerial commitment, and alignment with strategic objectives. Research on talent management emphasizes the importance of human capabilities in supply chain optimization [14], while studies of supply chain innovation demonstrate that organizational capabilities influence whether firms successfully respond to market opportunities [10]. Even the increasing use of digital and

interactive approaches in supply chain education reflects the growing demand for professionals capable of working effectively with complex digital systems [15]. Thus, the present findings are best understood within a sociotechnical perspective in which AI becomes a source of competitive advantage when technological capabilities are combined with human expertise, integrated processes, and adaptive management.

Overall, the findings support the conclusion that AI-enabled supply chain management functions as an important strategic capability in the electronics industry. The significant effects observed across all six dimensions show that competitive advantage is strengthened not by a single application of artificial intelligence, but by the cumulative and coordinated use of AI across forecasting, procurement, inventory management, production, logistics, and decision support. This result is consistent with the broader literature showing that supply chain competitiveness depends on integration, technological capability, agility, collaboration, and strategic coordination [22, 31, 32]. The findings therefore extend existing research by demonstrating empirically that AI-enabled supply chain management can explain a substantial proportion of competitive advantage in the electronics sector and that information integration and decision support appear to be especially influential within this relationship.

The present study has several limitations that should be considered when interpreting its findings. First, the research used a cross-sectional design, which means that the observed relationships reflect associations at one point in time and cannot provide definitive evidence of causality. Second, the data were collected exclusively from electronics-industry firms located in Tehran, which may limit the generalizability of the results to organizations operating in other regions, countries, or industrial sectors. Third, the study relied primarily on self-reported perceptions of managers, supervisors, and specialists, and such responses may be influenced by social desirability, subjective judgment, or differences in respondents' knowledge of organizational practices. Fourth, although the model incorporated several important dimensions of AI-enabled supply chain management, other potentially relevant factors such as organizational culture, AI readiness, data quality, cybersecurity, digital maturity, environmental uncertainty, and top-management support were not included. Finally, the present model focused primarily on direct relationships and did not investigate possible mediating or moderating mechanisms that might clarify how and under what

conditions AI-enabled supply chain management produces competitive advantage.

Future research should address these limitations through broader and more sophisticated research designs. Longitudinal studies could examine how the adoption and maturation of AI capabilities influence competitive advantage over time and could provide stronger evidence regarding causal direction. Future studies should also include firms from different provinces, countries, and industrial sectors and compare whether the strength of the relationships differs according to industry technology intensity, firm size, supply chain complexity, or market conditions. Researchers could combine survey data with objective organizational indicators such as logistics costs, inventory turnover, forecast accuracy, delivery lead time, defect rates, market share, and financial performance. Future models could also examine mediators such as supply chain agility, resilience, integration, innovation capability, and operational efficiency, as well as moderators including environmental uncertainty, digital maturity, organizational readiness, human AI competence, and technological infrastructure. Comparative studies between firms with low and high levels of AI maturity could further clarify the conditions under which AI-enabled supply chain management generates the strongest competitive returns.

From a practical perspective, managers in electronics firms should approach artificial intelligence as an integrated supply chain capability rather than as a collection of isolated technological applications. Priority should be given to developing unified data architectures that connect procurement, inventory, production, logistics, sales, and market information, because the findings indicate that information integration and decision support have the strongest relationship with competitive advantage. Organizations should also strengthen AI applications in inventory management and demand forecasting, where improvements can directly reduce uncertainty and support faster decisions. Investment in AI should be accompanied by employee training, data governance, process redesign, and cross-functional collaboration so that analytical outputs can be incorporated effectively into managerial decisions. Firms should establish clear performance indicators for AI initiatives, including forecast accuracy, inventory efficiency, delivery reliability, cost reduction, quality improvement, responsiveness, and innovation outcomes. Senior managers should also evaluate AI projects in terms of their contribution to strategic competitive priorities rather than focusing only on short-term automation benefits, thereby

ensuring that technological investments translate into sustained improvements in cost, quality, responsiveness, innovation, and flexibility.

Authors' Contributions

Authors equally contributed to this article.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

All procedures performed in this study were under the ethical standards.

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