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Article

The Impact of Artificial Intelligence on Flexible Manufacturing: A Case Study of the General Company for Electrical Industries

Raghdan Adnan Abdulrazzaq[1], Alassaad Lakhal[2]

1. PhD Student in Business Administration, Faculty of Economics and Management, University of Sfax, Tunisia
2. Professor Doctor in the faculty of Economic Sciences and Management, University of Sousse

* Correspondence: raghdanadnanabdulrazaqalni@gmail.com, lassaad.lakhal55@gmail.com

Abstract: This study aims to examine the impact of artificial intelligence (AI) technologies on enhancing flexible production within Iraqi telecommunications companies. It focuses on analysing the applications of AI, such as machine learning, big data, and smart supply chains. The study employs a descriptive-analytical approach and utilizes a questionnaire as the primary data collection tool, with a sample of 325 employees. The findings reveal a positive and statistically significant impact of AI technologies on flexible production, as they contributed to improving operational efficiency, reducing costs, and increasing adaptability to change. The study recommends expanding the use of AI, intensifying training efforts, and enhancing flexible production mechanisms to keep pace with dynamic market demands.

Keywords: : Artificial Intelligence, Flexible Production, Telecommunications Companies, Iraq.

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1. Introduction

In recent years, the world has witnessed rapid technological advancements, with artificial intelligence (AI) emerging as one of the most transformative innovations, reshaping the business environment. Artificial intelligence refers to a collection of technologies and systems that enable machines to simulate human capabilities in learning, analysis, and decision-making, thereby enhancing operational efficiency and quality across various sectors [1], [2], [3]. Within this context, the concept of flexible manufacturing has gained prominence as a strategic objective for organizations striving to adapt to the accelerating changes in the business landscape, particularly amidst ongoing technological disruptions [4].

The integration of AI with flexible manufacturing has become a necessary imperative. AI provides advanced tools for big data analytics, demand forecasting, and dynamic resource allocation, enabling organizations to respond to market shifts more swiftly and mitigate potential losses. The literature suggests that the application of AI technologies in production systems has led to improved agility in operational decision-making, reduced lead times in adjusting production lines, and increased capacity for customization in line with customer demands [5], [6].

The telecommunications sector has been among the most significant beneficiaries of AI, given its reliance on data processing and the delivery of dynamic services. With intensifying competition in this industry, the need for innovative solutions that enhance performance efficiency and improve customer experience has grown substantially [7]. Recent studies have shown that telecommunications companies adopting AI applications have achieved notable improvements in the flexibility of their operations, ranging from network management and customer behavior analysis to the development of new, market-responsive services [8], [9].

In the Iraqi context, telecommunications companies face compounded challenges, including economic fluctuations, unstable infrastructure, and mounting competitive pressures. These challenges underscore the urgent need to explore tools that can enhance operational flexibility and efficiency. Accordingly, this study aims to analyze the impact of artificial intelligence on achieving flexible manufacturing within Iraqi telecommunications companies, offering a clear perspective on how modern technologies can be leveraged to improve institutional performance [10]. Scholars have noted that developing countries frequently face additional challenges in adopting AI, including a shortage of technical expertise, which necessitates the application of scientific methodologies to assess the feasibility of such technologies in volatile environments [11].

The intersection of artificial intelligence and flexible manufacturing represents a convergence of technological innovation and operational effectiveness. This study aims to shed light on this nexus through an empirical case study of telecommunications companies in Iraq, with the goal of presenting a model that can be applied in other contexts.

Study the Problem

Considering the rapid and unprecedented pace of technological advancements in recent years, the greatest challenge facing business organizations, particularly in the telecommunications sector, is how to adapt to these developments in a way that ensures sustainability and competitive advantage. These transformations have created a new reality that requires companies to adopt smarter and more agile practices, enabling them to respond swiftly to evolving market demands. Within this context, artificial intelligence (AI) has emerged as one of the most powerful tools capable of bringing about fundamental changes in operational and production mechanisms, particularly in achieving flexible manufacturing and rapid responsiveness to change [12].

Despite the growing global interest in AI applications, studies exploring their impact on flexible manufacturing remain limited, especially within Arab business environments, and more specifically in the Iraqi telecommunications sector. This sector faces numerous challenges, including infrastructure deficiencies, rapidly shifting customer preferences, and intense competitive pressures. Accordingly, a clear research gap exists in examining the relationship between AI as a strategic tool and its role in enhancing production flexibility within this critical industry [13].

Based on the above, this study aims to investigate the impact of artificial intelligence on achieving flexible manufacturing, with a specific focus on telecommunications companies in Iraq. The aim is to provide a deeper understanding of AI's role and offer practical, locally relevant recommendations for its effective implementation [14].

Thus, the study problem can be framed through the following central research question: Does the application of artificial intelligence have an impact on achieving flexible manufacturing in telecommunications companies in Iraq?

This central question is further divided into the following sub-questions:

1. To what extent does artificial intelligence influence the flexibility of supply chains and production processes in telecommunications companies?
2. What is the impact of AI applications on the speed of response to customer needs?
3. Does artificial intelligence contribute to cost reduction and improved operational efficiency within the framework of flexible manufacturing?
4. What role does AI play in supporting production-related decision-making processes within telecommunications companies?

Significance Study

This study derives its significance from both academic and practical perspectives, particularly considering the profound transformations introduced by artificial intelligence (AI) technologies in business environments, especially amid the accelerating changes affecting the technology and telecommunications sectors [15], [16]. With increasing economic and technological challenges, there is a growing need to reassess traditional operational models and adopt tools and technologies that can enhance flexibility and efficiency in production processes. From this standpoint, AI is positioned as a central enabler for organizational adaptability, effective responsiveness to external changes, and the realization of a more flexible and sustainable production model.

Theoretically, the study contributes to enriching the literature on AI and its applications in production management, with a particular focus on the concept of flexible manufacturing, which has gained momentum as a strategic approach for organizations seeking to navigate unstable business environments. The study also offers a conceptual and analytical framework that links AI applications to the institutional ability, especially within telecommunications companies, to adopt dynamic production patterns capable of responding to rapid changes with efficiency [17], [18]. Thus, the study provides a valuable addition to the Arabic academic corpus by addressing a relationship that has not been adequately explored within the Iraqi context.

Practically, the importance of this study stems from its focus on the Iraqi telecommunications sector, a sector characterized by its vitality and sensitivity to global technological developments. This sector faces significant challenges, including infrastructure limitations, increasing competition, and shifting customer behaviors, making it an ideal domain for the application of AI tools to improve performance and enhance efficiency. By examining the practical reality of AI adoption in this sector, the study yields findings and actionable recommendations that can help companies formulate flexible production strategies and better respond to fluctuating demand.

The study's relevance is further heightened considering the digital transformation initiatives being pursued by many countries, with AI positioned as a cornerstone of the Fourth Industrial Revolution. Therefore, the findings of this study may offer substantial value to decision-makers in both the public and private sectors by informing policies that promote the integration of AI into operational processes and by highlighting the need for appropriate infrastructure and a knowledge base to support its effective implementation in telecommunications [19].

Accordingly, this study seeks to provide an in-depth analysis of the actual impact of AI on production flexibility, exploring its potential to improve performance, reduce waste, and enhance responsiveness to market and technological shifts. Moreover, the study's results may inform future investments in AI technologies, yielding direct returns in terms of operational efficiency and competitive advantage for telecommunications companies in Iraq.

Objectives of the Study

This study aims to explore and analyze the role of artificial intelligence (AI) technologies in enhancing flexible manufacturing within telecommunications companies in Iraq. To achieve this overarching aim, the study pursues the following specific objectives:

1. To analyze the concept of artificial intelligence and its applications in contemporary business environments, with a particular focus on its adoption and evolution in the telecommunications sector.
2. To identify the dimensions and core components of flexible manufacturing, and to examine how these dimensions relate to the ongoing digital transformations within business organizations, especially in the context of rapid technological advancement.

3. To investigate the current state of AI implementation in Iraqi telecommunications companies and assess the extent to which these technologies are utilized to improve both production and service-related operations.
4. To analyze the impact of artificial intelligence on production flexibility in terms of adaptability to sudden changes, cost reduction, and enhancement of operational efficiency within the telecommunications sector.
5. To measure the relationship between the use of AI and flexible manufacturing through an applied field-based model that allows for empirical testing of the study's hypotheses.
6. To offer practical recommendations that can assist Iraqi telecommunications companies in leveraging AI to support production strategies and achieve greater flexibility in a dynamic business environment.

Hypothesis of the Study

Considering the study's objectives and theoretical framework, the following hypotheses are proposed:

Main Hypothesis:

There is a statistically significant impact of artificial intelligence on flexible manufacturing, as applied to the General Company for Electrical Industries in Iraq.

From this main hypothesis, the following sub-hypotheses are derived:

1. H1**:** There is a statistically significant impact of artificial intelligence technologies on energy reduction.
2. H2: There is a statistically significant impact of artificial intelligence technologies on cost reduction.
3. $H0_1$: There is no statistically significant impact of artificial intelligence technologies on defect-free production.
4. $H1_1$: There is a statistically significant impact of artificial intelligence technologies on continuous improvement.

Study Model

1. Independent Variable: artificial intelligence.
2. Dependent Variable: Flexible production.

The following figure 1 shows the general framework for the study variables, as follows:

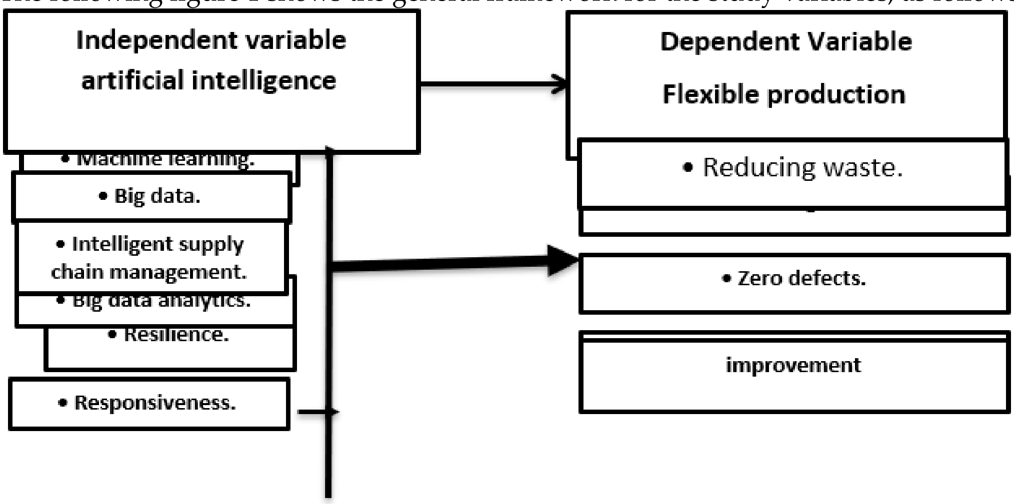

Figure 1. Model Framewoek of the Study

2. Materials and Methods

Given the nature of the study titled "The Impact of Artificial Intelligence on Flexible Manufacturing: A Case Study of Telecommunications Companies in Iraq", the researcher adopted the descriptive-analytical method, as it is the most appropriate for examining social and managerial phenomena. This approach enables an accurate description of the phenomenon as it exists, followed by an in-depth analysis to identify relationships and correlations between the variables under investigation.

A quantitative approach was employed through the development of a structured questionnaire, which served as the primary tool for collecting primary data from the study sample. The sample consisted of employees from telecommunications companies operating in Iraq, particularly those working in production, technology, and development departments.

The data collected were analyzed using a set of appropriate statistical methods, including descriptive statistics, regression analysis, correlation coefficients, and T-tests and ANOVA, utilizing data analysis software such as SPSS or SmartPLS.

Furthermore, the study's findings were supported by reviewing relevant previous literature to establish a solid theoretical foundation that reinforces the results and highlights the research gap the study aims to address.

Study terminology

1. Independent Variable: Artificial Intelligence, with its following dimensions: *Machine Learning, Big Data, Smart Supply Chain Management, Big Data Analytics*
   a. Machine Learning: Machine learning refers to a branch of artificial intelligence that enables systems to learn and improve from experience without being explicitly programmed. In the pharmaceutical industry, machine learning is used to analyze production-related data, enhance drug quality, and improve predictive models for factory performance and risk management.
   b. Big Data: Big data is utilized in the pharmaceutical industry to analyze vast amounts of information collected from diverse sources, including medical records, patient data, and production statistics. It improves visibility in operational performance, supports trend analysis for future drug demand, and enables accurate forecasting of market needs.
   c. Smart Supply Chain Management: AI technologies are utilized in smart supply chain management to enhance sourcing strategies, optimize material flow, reduce delays, and ensure efficient product distribution. AI tools also support real-time inventory analysis and accurate demand forecasting.
   d. Big Data Analytics: Big data analytics involves using advanced tools and techniques to analyze massive datasets collected from production systems, medical records, and customer information. It helps identify patterns, detect trends, and predict potential issues, thus enabling more effective decision-making and improved production efficiency.
2. Dependent Variable: Flexible Manufacturing, with its following dimensions: *Waste Reduction, Cost Reduction, Defect-Free Production, Continuous Improvement*
   a. Waste Reduction: Waste reduction refers to an organization's ability to eliminate non-value-adding activities, such as time, material, or effort waste, with the goal of achieving the highest possible efficiency. It is a key principle of lean manufacturing systems, where organizations strive to minimize waste at all stages of production using tools such as value stream mapping and value analysis. Waste reduction not only lowers costs but also improves response time and customer satisfaction.
   b. Cost Reduction: This dimension refers to an organization's ability to reduce overall production costs without compromising product quality or process efficiency. This is achieved through process optimization, effective use of technology, and resource savings. Cost reduction is a strategic objective for organizations aiming to strengthen their competitiveness in volatile markets. AI can play a vital role in this area by improving forecasting and minimizing resource waste.
   c. Defect-Free Production: Defect-free production signifies the system’s ability to deliver flawless products or services on the first attempt, eliminating the need for rework or corrections. It reflects the organization’s commitment to quality and

strict production control, serving as a key indicator of production flexibility and quality. Total Quality Management (TQM) is one of the primary tools supporting this goal, aiming to minimize defects and errors across all production stages.

d. Continuous Improvement: Continuous improvement refers to an organization's capacity to incrementally and consistently enhance its processes and products through feedback, innovation, and teamwork. This dimension is rooted in the Japanese Kaizen philosophy, which emphasizes ongoing, small-scale improvements as a path to high performance and quality. A work environment that encourages participation and performance analysis is essential for achieving this kind of improvement.

Literature Review

1. Studies Related to the Independent Variable (Artificial Intelligence):
   a. Brynjolfsson, Li, & Raymond aimed to examine the impact of using generative AI applications, such as virtual assistants, on enhancing productivity in workplace environments, particularly in customer service centres. The study involved 5,172 employees, with a subset provided with AI-based assistants to support their repetitive daily tasks. The findings showed a significant performance improvement of 15%, especially in simple and repetitive tasks. Notably, less experienced employees benefited more from these applications compared to their more experienced counterparts.
   b. El Hassani, El Mazgualdi, & Masrour explored how AI technologies, such as deep learning and neural networks, can enhance production efficiency in the manufacturing sector. The study focused on improving the accuracy of cost predictions, identifying factors that affect productivity, and reducing waste in operations. It also addressed how AI enhances human-machine interaction. Results indicated improved forecasting accuracy, reduced errors, and more efficient resource utilization, ultimately
2. Studies Related to the Dependent Variable (Flexible Manufacturing):
   a. Kamble et al. examined the role of Industry 4.0 technologies, including IoT, big data analytics, and cloud computing, in enhancing flexible manufacturing systems. The study emphasized how these technologies facilitate real-time decision-making, adaptive scheduling, and rapid customization in production environments. By surveying manufacturing firms in India, the authors found a significant correlation between the adoption of smart technologies and increased responsiveness and flexibility in manufacturing. The study recommended fostering digital transformation strategies and upskilling the workforce to leverage the benefits of flexible manufacturing fully.
   b. Zheng et al. conducted an empirical study on the digital transformation of small and medium-sized enterprises (SMEs) and its impact on manufacturing flexibility. The researchers utilized structural equation modeling to analyze data collected from over 300 SMEs in China. The results indicated that digital capabilities, such as real-time monitoring and agile supply chains, significantly improve firms' ability to adapt production processes to market fluctuations. The study concluded that flexible manufacturing requires not only technological investment but also managerial agility and employee empowerment to be effective.
3. Studies Addressing the Relationship between AI and Flexible Manufacturing:
   a. Bahrin et al. investigated the influence of smart automation and AI technologies in enabling flexible manufacturing within the context of Industry 4.0. The researchers demonstrated how AI tools, such as machine vision systems and deep learning, enhanced process accuracy and reduced defect rates. The integration of automation and AI reduced operational costs and enabled low-cost production of diverse units. A comparative analysis between traditional and AI-enabled production environments highlighted differences in the levels of flexibility. The

study emphasized the importance of integrating AI with organizational and managerial capabilities, recommending that companies strengthen their analytical infrastructure to leverage AI technologies effectively.

b. Zhong et al explored the relationship between AI and Industry 4.0, focusing on how these technologies contribute to the development of intelligent and flexible production systems. The study analyzed applications of machine learning, the Internet of Things (IoT), and predictive analytics. Results showed that AI integration improves operational efficiency, reduces waste, and enables proactive responses to market changes. The study emphasized the importance of enhancing digital infrastructure to support operational flexibility, as demonstrated by real-world case studies.
c. Lee et al. examined the role of AI and big data analytics in enhancing production flexibility within the Industry 4.0 environment. Using empirical analysis and case studies, the research evaluated the impact of AI technologies on decision-making and operations management. The findings indicated that smart algorithms improved production scheduling, reduced downtime, and increased distribution efficiency. The integration of AI with cloud computing enabled real-time responsiveness to change. The study highlighted that these technologies support mass customization without compromising efficiency, addressing infrastructure and human skill challenges, and recommending investment in digital and analytical capabilities.
d. Wamba-Taguimdje et al. investigated the role of AI in enhancing companies' operational flexibility through big data analytics. Based on quantitative data from industrial firms, the study identified the relationship between AI applications and adaptability to environmental changes. The results showed that AI enhances predictive capabilities and facilitates proactive problem-solving. Technologies such as neural networks and unstructured data analysis have been shown to support flexible production decisions. The study positioned AI as a strategic tool for ensuring operational sustainability in volatile business environments and recommended investing in digital infrastructure and employee upskilling.
e. Ribeiro et al. evaluated the impact of AI technologies on the flexibility of supply chains and production systems in industrial companies. Using data from European firms employing AI for demand forecasting and resource management, the study found that AI facilitates adaptation to market fluctuations and improves responsiveness to shifting demands, key indicators of flexible manufacturing. Smart algorithms have been shown to reduce waste and improve final product quality significantly. The researchers emphasized the importance of collaborative models between humans and intelligent systems, examining AI's role in business continuity and innovation in unstable environments. They recommended supporting digital infrastructure and fostering a culture of organizational learning to maximize the benefits of AI.

Commentary on Previous Studies :

Previous studies have agreed on the importance of artificial intelligence (AI) in enhancing flexible production by improving efficiency, reducing costs, and adapting to changes. They also emphasized the integration of AI with other technologies such as big data and cloud computing to support production decision-making. However, these studies varied in terms of context and the sectors under investigation. Some focused on heavy or general industries without a particular emphasis on the pharmaceutical sector. Moreover, the research methodologies ranged from case studies to quantitative data analysis, resulting in varying outcomes and recommendations. Most studies have not established a direct link between AI and production efficiency within a specific industrial context. Therefore, the current study stands out by addressing the relationship between AI and flexible production in pharmaceutical manufacturing companies, aiming to fill this research gap through the development of an applied model and field analysis that reflects the unique characteristics of this vital sector.

Study Population and Sample

The study population consists of employees at the General Company for Electrical Industries in Diyala Governorate, totaling 2,117 individuals. Due to the difficulty of reaching all members of the research population, along with time and resource limitations, the researcher employed the simple random sampling technique to ensure a scientifically accurate and representative selection. Based on the standard sample size formula, with a 95% confidence level and a 5% margin of error, the sample size was determined to be 325 individuals. This number is considered sufficient and appropriate for conducting statistical analyses and obtaining results with scientific and objective significance. The statistical formula used to calculate the sample size is as follows:

$$n = \frac{NP(1-P)x^2}{(N-1)d^2+P(1-P)x^2}$$

Where:

1. n: The required sample size.
2. N: The study population size.
3. P: The maximum proportion of the characteristics to be studied in any population, which was considered 50%.
4. D: The standard error rate is ±0.05.
5. Z: The standard score corresponds to a confidence level of 1.96.

By substituting these values into the formula, the sample size was determined to be 325 individuals, which is deemed statistically adequate and appropriate for conducting the required analyses and obtaining results of scientific and objective significance.

3. Results and Discussion

Validity and Reliability Testing

Table 1. Reliability and Construct Validity Coefficients of the Study Dimensions

Dimension	Number of Items	Cronbach's Alpha (Reliability)	Construct Validity Coefficient*
Machine Learning	4	0.619	0.786
Big Data	4	0.612	0.782
Smart Supply Chain Management	4	0.603	0.777
Intelligent Customer Interaction	4	0.611	0.781
Artificial Intelligence (Total)	16	0.611	0.782
Waste Reduction	5	0.602	0.776
Cost Reduction	5	0.610	0.781
Defect-Free Production	4	0.612	0.782
Continuous Improvement	4	0.623	0.789
Flexible Production	18	0.612	0.782

Construct Validity = √ (Cronbach's Alpha)

As shown in Table 1, all study dimensions achieved acceptable levels of reliability and validity, indicating that the data collection instrument is statistically sound and reliable. The Cronbach's Alpha values ranged between 0.602 and 0.623, which are considered acceptable for exploratory studies, particularly in emerging fields such as artificial intelligence and its industrial applications. The highest reliability coefficient was observed for the "Continuous Improvement" dimension (α = 0.623), reflecting strong internal consistency. Other dimensions, such as "Machine Learning," "Big Data," "Intelligent Customer Interaction," and "Defect-Free Production," reported coefficients ranging from 0.611 to 0.619, indicating reasonable reliability. The lowest value was recorded for "Waste

Reduction" (α = 0.602), which still falls within the minimum acceptable threshold in scholarly research. The construct validity coefficients, derived from the square root of Cronbach's Alpha, ranged between 0.776 and 0.789, denoting an overall good level of construct validity. This confirms that the items under each dimension accurately measure their respective theoretical constructions. These results support the robustness of the research instrument and its capability to capture the intended study variables effectively and reliably, thus allowing for meaningful generalization to the target population.

Normality testing

To examine whether the data follow a normal distribution, the Kolmogorov–Smirnov (K–S) test was employed. The results are shown in Table 2.

Table 2. Kolmogorov–Smirnov Normality Test Results

Dimension	Sig. Value	Z-Statistic
Machine Learning	0.011	1.07
Big Data	0.066	3.00
Smart Supply Chain Management	0.080	2.05
Intelligent Customer Interaction	0.067	2.20
Artificial Intelligence (Total)	0.097	2.41
Waste Reduction	0.023	1.15
Cost Reduction	0.060	1.13
Defect-Free Production	0.017	1.70
Continuous Improvement	0.070	1.53
Flexible Production	0.020	2.77
Overall Questionnaire Dimensions	0.071	2.05

As illustrated in Table 2, Sig. Values for all dimensions are greater than the significance level ($\alpha \geq 0.05$), indicating that the data follows a normal distribution. Therefore, parametric statistical tests were deemed appropriate for analyzing the data to answer the study questions and test the proposed hypotheses.

Overall Indicators for Artificial Intelligence analysis

Table 3. Means, Weights and T-test Results for AI Dimensions (n = 303)

Dimension	Mean	Weight	T-Value	Sig.	Rank
Machine Learning	3.69	73.86%	14.67	0.000*	3
Big Data	3.78	75.52%	19.14	0.000*	1
Smart Supply Chain Management	3.71	74.26%	17.67	0.000*	2
Intelligent Customer Interaction	3.61	72.28%	11.94	0.000*	5
Artificial Intelligence (Overall)	3.70	73.96%	21.57	0.000*	—

Statistically Significant at $\alpha \geq 0.05$

The results in Table 3 reveal that the overall mean for AI dimensions was 3.70 out of 5, with a

Weight of 73.96%, and a T-value of 21.57 at a high statistical significance (Sig. = 0.000). This indicates statistically significant differences between the actual and hypothetical mean (value = 3), reflecting strong agreement among the respondents regarding the implementation of AI dimensions in food companies in Iraq. Ranking the dimensions based on agreement levels, "Big Data" ranked first (mean = 3.78, weight = 75.52%, T = 19.14), followed by "Smart Supply Chain Management" (mean = 3.71), "Machine Learning" (3.69), and finally "Intelligent Customer Interaction" (3.61). These results collectively highlight respondents' recognition of the importance of adopting AI dimensions to enhance lean marketing effectiveness. Notably, the dimension of "flexibility" received the lowest ranking with a mean of 3.61, corresponding to a weight of 72.28%.

Overall Indicators for Competitive Advantage analysis

Table 4. Means, Weights, and T-Test Results for Competitive Advantage Dimensions (n = 303)

Dimension	Mean	Weight	T-Value	Sig.	Rank
Waste Reduction	3.78	75.64%	20.60	0.000*	1

Cost Reduction	3.74	74.89%	18.75	0.000*	3
Defect-Free Production	3.78	75.52%	20.32	0.000*	2
Continuous Improvement	3.66	73.27%	15.15	0.000*	4
Flexible Production	3.74	74.83%	23.81	0.000*	—

Statistically significant at $\alpha \geq 0.05$

The findings in Table 4 show that the overall mean of competitive advantage dimensions in food companies was 3.74 out of 5, with a weight of 74.83%, and a T-value of 23.81, all at a statistically significant level (Sig. = 0.000). This demonstrates a strong level of agreement among respondents regarding the realization of competitive advantage within the companies studied. In terms of ranking, "Waste Reduction" came first (mean = 3.78, T = 20.60), followed by "Defect-Free Production" (3.78, T = 20.32), and "Cost Reduction" (3.74, T = 18.75). "Continuous Improvement" ranked fourth (3.66, T = 15.15). These results indicate the participants' high awareness of the importance of achieving competitive advantage—especially in reducing waste, ensuring quality, and minimizing costs within the food sector environment.

Hypothesis testing

Main Hypothesis Testing: The main hypothesis of the study posits that: *There is a statistically significant impact of artificial intelligence on flexible manufacturing, as applied to the General Company for Electrical Industries in Iraq.*

Table 5. Regression and Linear Correlation Coefficients for the Impact of Artificial Intelligence on Flexible Manufacturing

Variables	**Regression Coefficient (B)**	**Std. Error**	**Beta**	**T-Value**	**Sig.**
(Constant)	63.078	3.523		17.904	0.000
Machine Learning	0.041	0.126	0.018	0.321	0.749
Big Data	0.126	0.126	0.056	1.004	0.316
Smart Supply Chain Management	0.099	0.121	0.046	0.822	0.411
Intelligent Customer Interaction	0.076	0.121	0.035	0.627	0.531

Significance level at $\alpha \leq 0.05$.

As shown in Table 5, the impact of artificial intelligence on flexible manufacturing was not statistically significant at the 0.05 level of significance—all Sig. Values for AI dimensions were greater than 0.05, indicating a lack of statistically significant influence from the studied dimensions—specifically, the Sig. Value for Machine Learning was 0.749, for Big Data 0.316, for Smart Supply Chain Management 0.411, and for Intelligent Customer Interaction 0.531. All exceed the acceptable significance threshold.

Accordingly, based on these results, the null hypothesis cannot be rejected. This implies that there is no statistically significant relationship between artificial intelligence (in its various dimensions) and flexible manufacturing within the company under study.

Study Findings

Findings Related to the Independent Variable (Artificial Intelligence): The study concluded that all dimensions of artificial intelligence analyzed — including Machine Learning, Big Data, Smart Supply Chain Management, and Intelligent Customer Interaction — demonstrated a positive and strong influence on enhancing flexible manufacturing within the General Company for Electrical Industries. The mean scores for all AI dimensions were high, ranging between 3.61 and 3.78, reflecting a high degree of agreement among respondents regarding the adoption of AI technologies to improve operational efficiency and production flexibility. The (T) test values for all dimensions were statistically significant (Sig. = 0.000), indicating that these dimensions have a significant positive effect on improving performance in the company studied.

Findings Related to the Dependent Variable (Flexible Manufacturing): Results revealed that the concept of flexible manufacturing at the General Company for

Electrical Industries achieved high performance levels. The overall mean for this dimension was 3.74, with a weight of 74.83%, indicating the company's ability to adapt to rapid changes in the business environment. The analysis of sub-dimensions such as "Waste Reduction," "Defect-Free Production," and "Cost Reduction" showed a clear impact on improving both flexibility and productivity within the organization. Furthermore, the findings suggest a strong association between the adoption of artificial intelligence technologies and flexible manufacturing, as AI contributes to improved manufacturing processes, cost reduction, and enhanced responsiveness to market changes — thereby promoting greater sustainability in the company's operations.

4. Conclusion

a. Enhancing the Orientation Towards Artificial Intelligence: It is recommended to expand the use of artificial intelligence technologies in the General Company for Electrical Industries, particularly in the areas of *machine learning* and *smart supply chain management*, as these dimensions have shown a significant positive impact on improving production efficiency. The company should invest in these technologies to provide innovative and effective solutions that support flexible production enhancement.

b. Continuing Training and Development: It is essential to intensify training and development programs for employees on the use of artificial intelligence technologies and their applications in the production field. This includes training staff in big data analysis and the use of smart algorithms to improve decision-making within production departments.

c. Improving Work Mechanisms in Flexible Production: It is advisable to enhance the implementation of flexible production dimensions, especially in the areas of *waste reduction* and *defect-free production*, by developing work methods and improving monitoring and quality techniques using artificial intelligence. These efforts can contribute to reducing costs and increasing productivity sustainably.

d. Continuing the Study of Digital Transformations: It is recommended to continue studying the impacts of digital transformations in the work environment and to expand the use of artificial intelligence to improve technological capabilities and enhance the company's ability to adapt to modern industrial changes, thereby strengthening production's ability to meet changing demands.

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