

Smart Manufacturing Using Artificial Intelligence and its Impact on Developing Lean Marketing Strategies

Zainab Tuama Sultan, Mohammed Edan Alkhazraje*, Esraa Ali Muhsin

Institute of Administration Rusafa, Middle Technical University, Baghdad, Iraq. *Email: alkhazrje1991@mtu.edu.iq

Received: 01 March 2026

Accepted: 03 March 2026

DOI: <https://doi.org/10.32479/irmm.23984>

ABSTRACT

With the rapid digital transformation and adoption of technologies such as artificial intelligence, the Internet of Things, and big data analysis in manufacturing processes, it has become necessary to develop marketing strategies that rely on flexibility and high efficiency. This research focuses on employing smart manufacturing to improve the marketing decision-making process, reduce waste, and increase the ability to adapt to market variables. This research aims to explore the relationship between smart manufacturing and lean marketing strategies and how integrating these two fields can enhance the competitiveness of industrial enterprises. The Baghdad Sewing Factory (Al-Khaym Factory) was chosen as the site for implementing the research. The descriptive analytical approach was used and a purposive sample of managers and officials in the factory departments was selected, specifically those related to the production and manufacturing departments. (79) responses were collected. The data were analyzed using Statistical Package for the Social Sciences V.26S. The research concluded that smart manufacturing affects the development of lean marketing strategies and that the combination of smart manufacturing and lean marketing contributes to improving the operational and marketing performance of the manufacturing institution.

Keywords: Smart Manufacturing, Lean Marketing, Artificial Intelligence Manufacturing, Waste Reduction

JEL Classifications: M31, M11, L23

1. INTRODUCTION

In light of the rapid changes witnessed by the industrial world, it has become necessary for organizations to adopt innovative strategies to keep pace with market developments and enhance their competitive capabilities. Smart manufacturing, which relies on advanced technologies such as artificial intelligence, the Internet of Things, and big data, represents a new industrial revolution aimed at improving operational efficiency, reducing costs, and increasing productivity. At the same time, Lean marketing strategies have emerged as an effective tool to adapt to rapid changes in customer preferences and the challenges of volatile markets, by providing flexible and responsive marketing solutions. (Salam and Muhammad, 2022) See smart manufacturing as one of the concepts based on high technology that aims to automate production and introduce artificial intelligence into the processes

of planning, implementation, control, and continuous improvement of all production processes and production resources. Smart manufacturing aims to integrate production systems, warehouses, and logistics services into a digital and automated manufacturing environment (Wang & Hsu, 2021). (Al-Khafaji and Hamada, 2022) indicate that lean marketing is an approach that focuses on customers and value and attempts to eliminate all types of waste related to marketing operations and understand all activities and processes that the target customer does not want or does not request and do not meet his expectations (Moi and Cabiddu, 2021). The study (Sukhawattanakun and Supapon, 2024) confirms that the main goal of establishing a smart manufacturing system is to Lean operations to increase the efficiency and independence of the manufacturing system and improve the efficiency of marketing activities. This research aims to study the relationship between smart manufacturing and lean marketing and to bridge

the research gap between smart manufacturing and lean marketing strategies and how the integration of these two aspects can contribute to enhancing companies' performance and increasing their ability to innovate and adapt to continuous changes. By reviewing the theoretical foundations and practical applications of these strategies, this research seeks to understand how smart manufacturing can constitute a fundamental pillar for the success of lean marketing, and how companies can benefit from this integration to achieve a sustainable competitive advantage. This research was divided into four sections, including the literary contributions first, then the research methodology second, the third section included a presentation and discussion of the results, and finally, the fourth section included the conclusions, recommendations, and future studies.

2. LITERATURE REVIEW

2.1. Smart Manufacturing

Smart manufacturing refers to manufacturing that focuses on meeting customer desires while maintaining high quality and specifications and controlling the cost of producing a specific product, especially in organizations operating in a highly competitive environment (Hawas and Yeridi, 2021). (Al-Taie and Al-Samman, 2022) define smart manufacturing as the shift from traditional manufacturing to smart manufacturing based on technology, artificial intelligence, the Internet of Things, and continuous future manufacturing to achieve long product life cycles and greater customization effectively. Therefore, smart manufacturing integrates physical and electronic technologies that make manufacturing technologies more complex and accurate to improve performance and quality (Kessler and Arlinghaus, 2022). (Evjemo et al., 2020) indicate that smart manufacturing is a set of procedures, methods, and tools that rely on artificial intelligence to support design, planning, and manufacturing and that can adapt, learn, and self-improve in integrating factory activities with production activities. (Salam and Mohamed, 2022) believe that the progress in computer technology and machine building has led to the automation of manufacturing, in which work is operated and materials and components are transported by automated material handling systems (Leng et al., 2021). They are stored in automated storage and retrieval systems depending on the scope and degree of automation of the manufacturing floor and the integration of different functional production areas. Different terms have been used to describe automated manufacturing since the 1980s, starting from flexible manufacturing to computer-integrated manufacturing and smart manufacturing (Arcidiacono et al., 2023). (Hawas, 2020) believes that smart manufacturing has led to the automation of manufacturing, as machines today are largely managed by computer programs, and materials and spare parts are transported by automated systems in handling materials.

Ismail (2023) defines smart manufacturing as the type of manufacturing that relies on artificial intelligence technologies in its operations, as these systems have intelligence capabilities such as learning, reasoning, decision-making, and others. They can also benefit from various artificial intelligence technologies to improve the performance of manufacturing operations (Leng et al., 2021). To perform specific functions, smart manufacturing

systems can be designed in a way that enables them to work when it is difficult to measure results, where frequent changes in operations are possible, and when there are no prior decisions available regarding the system's behavior (Tantawi et al., 2023). (Al-Awadi and Tufan, 2023) believe that in smart manufacturing during the first industrial revolution period, the design of the physical system did not have any considerations for the control system or digital management. However, in the era of the second industry, large-scale production and assembly lines appeared, and the control system began to be taken into account due to the need for a schedule of operations and efficient operations. As for the third stage of industry, computers, and automation began to appear, and the design of physical systems and control systems were both dominant. With the emergence and provision of big data, the provision of computing capabilities, and the spread of smart devices, manufacturing is moving towards a new era, which is the era of the Fourth Industrial Revolution. The new manufacturing model is called smart manufacturing, which combines artificial intelligence and communications technologies (Mourtzis et al., 2021). Among its most important goals are increasing flexibility, automation, business intelligence, integration, and sustainability (Meng et al., 2018).

Hamoudi et al., (2022) define that smart manufacturing aims to meet the individual requirements of customers and increases the company's competitiveness. Therefore, organizations seek to develop production processes in line with the desires and requirements of customers and the additional restrictions imposed on them, as customer desires are not fixed and are subject to continuous change. (Al-Hassoun, 2021) believes that smart manufacturing is manufacturing that focuses on meeting customer desires while maintaining high quality and specifications and controlling the cost of producing a specific product, especially in organizations operating in a highly competitive environment, as a simple change in work or performance can lead to a big difference in the long term in the company's reputation and retention in the minds of customers. It is necessary to develop an evaluation system that takes into account and reduces costs, as companies rely on smart manufacturing to save a lot of money that may be wasted due to the high costs of traditional manufacturing (Aldrini et al., 2024). In addition to raising production efficiency and achieving quality standards (Yan et al., 2023). By adopting smart and sustainable data-driven manufacturing systems, enterprises can improve energy efficiency and reduce energy costs for companies via the cloud platform, by monitoring energy consumption in real-time, evaluating energy efficiency management, and analyzing it optimally, taking into account demand response (Ma et al., 2020). Smart manufacturing systems obtain real-time data that improves decision-making accuracy, enhances factory efficiency and performance, and increases overall productivity (Qu et al., 2019). Based on big data analytics, the smart manufacturing system improves manufacturing process control processes, including schedule planning, diagnosis, predictive supply, and evaluation (Dubey et al., 2020). Smart manufacturing technologies are characterized by their ability to monitor and evaluate the economic performance of a single manufacturing process or subunit, diagnose the causes of poor performance, and make appropriate decisions to improve the

overall performance of the system, i.e. the ability to self-improve (Othman & Yang, 2023). In addition to detecting defects and making decisions to recover from them, i.e. self-adaptation and the ability to monitor themselves, diagnose the causes of failure, and solve problems (Ren et al., 2024). Among the pillars of smart manufacturing are those referred to by (Al-Hassoun, 2021) (Al-Sahlani and Abdul, 2019), which are:

- **Manufacturing technologies and processes:** As it is expected that manufacturing technologies and processes will emerge in different forms in the near future, the goal of smart manufacturing is to create production processes and manufacturing systems that are adaptable locally or globally.
- **Materials:** Smart materials and products will take their own development path and smart manufacturing is open to all types of materials, whether organically based or used in future products, and each industrial company differs from another in the use of materials.
- **Data:** As we witness a data revolution in the field of manufacturing, some of which is the result of the development of sensors and wireless technologies and the advancement in the field of data analysis, smart manufacturing systems obtain real-time data that improves and accurately makes decisions.
- **Predictive engineering:** It is one of the latest additions to manufacturing solutions that will lead to proactive facilities rather than responsive facilities based on human needs and for the optimal solution to the problem.

2.2. Lean Marketing

The philosophy of lean marketing meets the philosophy of lean manufacturing in terms of unity of purpose and intellectual logic. Both philosophies stem from one root represented in the pursuit of reducing activities and practices that do not constitute value to eliminate existing sources of waste, meaning removing all activities that do not contribute to adding innovative value (Al-Hamdani and Al-Salem, 2023). Lean marketing focuses on customers and value and seeks to eliminate all types of waste related to the marketing process (Sachdeva and Kazem, 2022). (Raouf and Hamdi, 2013) define lean marketing as accomplishing many tasks through the fewest possible number of activities in a way that ensures that the customer gets what he wants. It is a tool for business growth and removing flabbiness (Katara, 2022). (Al-Janabi and Al-Jabouri, 2020) see lean marketing as an extension and application of the concept of lean thinking in the field of marketing, which is a theory derived from production practices that comprehensively take into account customer needs and the actual situation of sales in operations management. (Aleksandrova, 2023) Sees that the concept of lean marketing allows the application of lean principles in multiple fields such as manufacturing, project management, supply chain, marketing, and service management. (Al-Qoutji and Al-Mulla Hassan, 2021) Indicate that the use of digital marketing and social media as modern marketing tools represents one of the extensions of lean marketing. Lean marketing seeks to improve marketing operations and enhance sustainability with a focus on environmental protection practices, waste management, providing clean work environments, training, self-organization, and best food handling practices to enhance product quality and safety (Vallejo-Chávez et

al., 2023, Ali and Obaid., 2024). Reducing waste and inefficiency of operations and increasing the professional effectiveness of workers in all areas of marketing (Sukhawattanakun and Supapon, 2024). It also aims to continuously eliminate waste through practical parts for continuous improvement creating customer-oriented solutions and reducing the consumption of available resources (Rahimi, 2020). Enhancing the final added value to the end user, eliminating waste, reducing inventory size, and maximizing flow and flow in production through the pull system (production according to customer demand) (Samaka and Kazem, 2022). Al-Janabi and Al-Jabouri, 2020, Al-Hamdani and Al-Salem, 2023, Muharab, 2019) agree that the dimensions of lean marketing are:

- **Reducing excessive marketing operations:** Excessive marketing operations occur when there is a deviation in what the company offers in terms of products and services and what the market actually needs.
- **Reducing unnecessary processing:** Unnecessary processing refers to the random use of resources that exceed the organization's needs, so it is difficult to identify and eliminate this type of waste, whether in the production or marketing process. It includes reducing excess inventory, reducing unnecessary transportation, and reducing unnecessary movements (Muharib, 2019).
- **Reducing waiting times:** Waiting represents the period elapsed before customers get the desired value from using a specific product. If the waiting time is not planned, it is often viewed as a waste, and the customer always views waiting time as an unpleasant and unsatisfactory time for him.
- **Reducing defective outputs:** Quality problems and defects that appear in products are a major challenge to customer satisfaction. Increasing defects in products can give a negative impression to customers, which may lead to a loss of confidence in orders (Al Khazraje, 2024). It is necessary to provide customer requirements from a tangible perspective and adhere to quality standards that ensure customer satisfaction.
- **Activating underutilized skills:** This type of waste indicates that the lack of use of employee suggestions means the absence of an open and conscious organizational culture that enables them to make suggestions and participate effectively in process mapping activities without fear of their suggestions being rejected (Ali et al., 2021). Employees will feel frustrated when they are not involved in decision-making processes or when their opinions and suggestions are not respected (Al-Khazraje and Zahra, 2023). When companies are content to alienate their employees, they will not be able to eliminate waste, which hinders the sustainable improvement of their marketing performance (Hassan and Al-Jubouri, 2023).

3. MATERIALS AND METHODS

3.1. Research Problem

With the rapid development of industrial technology and increasing global competition, organizations face a major challenge in how to benefit from smart manufacturing to improve their operational efficiency while maintaining their ability to

quickly adapt to changing customer needs. Lean marketing represents a framework that enables companies to respond quickly to market requirements and reduce waste in marketing operations, but there is a gap in practical and theoretical understanding of how to integrate smart manufacturing strategies with Lean marketing to achieve maximum benefit. The research problem lies in the lack of studies that address the integration between smart manufacturing and Lean marketing as a comprehensive strategy to enhance the competitiveness and innovation of productive companies. Industrial companies also face difficulties in applying these new concepts simultaneously and effectively. Therefore, this research seeks to analyze this gap and provide a comprehensive framework that helps companies achieve a balance between modern technology and flexible marketing strategies to improve overall performance and increase customer satisfaction. This research attempts to answer the following questions:

QR1: Is there a role for smart manufacturing in developing Lean marketing strategies?

QR2: What is the level of reliance of the Baghdad Sewing Factory (Al-Khayam Factory) on smart manufacturing and does the company rely on artificial intelligence technologies to enhance its production and manufacturing activities?

3.2. Importance of the Research

The importance of this research is highlighted by highlighting one of the most prominent modern trends in industry and marketing, which is the integration between smart manufacturing and lean marketing. Today's business sector is facing rapid transformations due to accelerating technological developments and changing customer requirements, which makes it necessary to find innovative solutions that combine operational efficiency and marketing flexibility. This research provides scientific and practical value by bridging the gap in the literature on smart manufacturing and developing lean marketing strategies and helps understand how industrial companies can benefit from this relationship to achieve sustainable competitive advantage. The research will also provide practical guidance for organizations on how to apply lean marketing strategies in conjunction with adopting smart manufacturing, which may lead to improved operational efficiency and increased speed of response to market changes. Therefore, this research is of great importance to industrial companies as it provides a new vision for how to adapt to future challenges in the business world.

3.3. Research Objectives

This research seeks to analyze the relationship between smart manufacturing and lean marketing and understand how smart manufacturing can contribute to developing lean marketing strategies to improve the overall performance of the Baghdad Sewing Factory (Tent Factory). This research also aims to study the benefits that industrial companies can obtain from integrating smart manufacturing with lean marketing, such as improving efficiency, reducing waste, and increasing the speed of response to the market. And to provide a conceptual framework and develop a business model that industrial institutions can rely on to implement smart manufacturing and lean marketing in an integrated and effective manner.

3.4. Research Sample and Measurement Tool

The Baghdad Sewing Factory (Tent Factory), one of the formations of the Ministry of Industry and Minerals, was chosen as a site for implementing the research. This factory was chosen as a site for implementing the research because it is part of the Ministry of Industry and Minerals and has an effective tent manufacturing factory, which makes it an ideal site for studying the impact of artificial intelligence in the fields of smart manufacturing and developing lean marketing strategies. A deliberate sample was chosen that included all the research community, managers, and officials in the factory departments, specifically those related to the production and manufacturing departments, numbering (83) managers at various levels, which enhances the sample's representation, reduces bias, and allows the results to be generalized at various levels within the factory. The sample included managers and officials from factory departments related to manufacturing and marketing, which ensures the existence of diversity in opinions and experiences related to smart manufacturing and its impact on lean marketing strategies. The questionnaire was used as a tool for data collection. Data was collected from sample members, and after reviewing the questionnaires, it was found that the number of valid questionnaires for measurement was only (79) questionnaires, representing 95% of the study community. The questionnaire was designed according to a five-point Likert scale. The questionnaire included two sections, the first section included identification information, while the second section included questions related to the research variables. The questions of the independent variable, smart manufacturing, were formulated based on the (Al-Bakri, 2021) scale, which included (15) questions, while the questions of the dependent variable, Lean marketing, were formulated according to the (Al-Bakri, 2021) (Muharib, 2019) scale, which included (20) questions. The researchers made the necessary adjustments to make the scale more suitable for this research environment and sample. The descriptive analytical approach was used to analyze the research data based on the Statistical Package for the Social Sciences V.26S and Smart PLS4 programs to reach the results.

3.5. Research Hypotheses

The research hypotheses were built after reviewing the relevant literary contributions and according to the problem of this research and to achieve its objectives in formulating the hypotheses according to the relationship of correlation and impact between smart manufacturing and lean marketing and its dimensions (reducing excessive marketing operations, reducing unnecessary treatments, reducing waiting times, reducing defective outputs, activating unutilized skills) and the following hypotheses were formulated:

- (H₁): There is a significant and positive effect between smart manufacturing and developing lean marketing strategies
- (H₂): There is a significant and positive effect between smart manufacturing and reducing excessive marketing operations
- (H₃): There is a significant and positive effect between smart manufacturing and reducing unnecessary treatments
- (H₄): There is a significant and positive effect between smart manufacturing and reducing waiting time
- (H₅): There is a significant and positive effect between smart manufacturing and reducing defective outputs

- (H_0): There is a significant and positive effect between smart manufacturing and activating unutilized skills.

Figure 1 presents the research model, illustrating the relationships among the study variables and the proposed hypotheses linking the independent and dependent variables and their respective dimensions.

4. RESULTS

4.1. Validity and Reliability Test

To ensure the validity and reliability of the questionnaire and the data collected from the sample members' answers, the researchers used the reliability coefficient test (Cronbach's Alpha) to measure the levels of validity and reliability according to (Hassan and Al-Jubouri, 2023). The required values must exceed the threshold of (0.700). (Table 1) shows that the value of the reliability coefficient (Cronbach's Alpha) for the first variable, smart manufacturing, reached (0.900), which is a high percentage that exceeds the acceptable limit of (0.700), indicating high stability for all paragraphs of this independent variable. As for the dependent variable, Lean marketing, the value of the reliability coefficient reached (0.893), which also reflects a high level of stability. All paragraphs of the questionnaire also achieved a high overall reliability coefficient value estimated at (0.946), as shown in (Table 1). The composite reliability test CR was also conducted. According to (Fakhry et al., 2024), if the composite reliability value is >0.70 , it indicates good consistency and high reliability and that the paragraphs measure the variable to be tested. (Table 1) shows the CR value for smart manufacturing, which is (0.948), which is >0.70 , and the alpha coefficient for the lean marketing variable is (0.959), which is also >0.70 , indicating that this scale has validity and reliability.

4.2. Sample Adequacy Test

The researchers resorted to testing the adequacy of the sample size using the Kyr-Meier-Oklin (KMO) test according to (Hair et al., 2017). The value must be significant and >0.50 to indicate the adequacy of the sample size. (Table 2) indicates that smart manufacturing obtained a value of (0.869) and lean marketing reached a value of (0.828), both at a significance level of <0.01 and >0.50 , thus achieving the condition of adequacy of the sample size for the research variables.

4.3. Descriptive Analysis

(Table 3) shows that the weighted arithmetic mean of the smart manufacturing dimension reached (3.703), which is higher than

the hypothetical mean of (3), as (Al Khazraje, 2024) indicates that if the arithmetic mean exceeds the hypothetical mean, the sample members' answers tend towards agreement. The standard deviation was also recorded (0.605), which reflects a high degree of homogeneity in the sample's answers about smart manufacturing. These results confirm the agreement of the majority of the sample members on smart manufacturing in the company under study. The weighted arithmetic mean of the lean marketing dimension was (3.746), which is higher than the hypothetical mean of (3), indicating that the sample members' answers tend towards agreement on this variable. The standard deviation was also recorded (0.522), which reflects a high degree of homogeneity in the sample's answers about lean marketing.

4.4. Correlation Test

(Table 4) shows the existence of a significant correlation between smart manufacturing and the development of lean marketing strategies, at a significance level of (0.01) and a confidence level of (99%). The value of Pearson's correlation coefficient between the two variables reached (0.922**), in addition to the existence of a strong significant correlation between smart manufacturing and lean marketing strategies (reducing excessive marketing operations, reducing unnecessary operations, reducing waiting time, reducing defective outputs, and activating underutilized skills).

4.5. Impact Hypothesis Testing

The researchers relied on the (F-test) test to determine the acceptance or rejection of the hypothesis of the impact of smart manufacturing on the development of lean marketing strategies. According to (Al Khazraje and Sideeq, 2024), if the probability value corresponding to the calculated F value is less than the significance level (0.01), the hypothesis is accepted, which confirms its acceptance with a confidence rate of 99%. The coefficient of determination (R^2) was also relied upon to clarify the percentage of explanation of the impact of smart manufacturing on lean marketing, as its value reached (84.9%), indicating that 84% of the changes in smart manufacturing are in lean marketing. The calculated F value reached (438.761) at a significance level (0.01), thus confirming a significant impact of smart manufacturing on the dependent variable, lean marketing. Accordingly, the hypothesis (H_1) was accepted, which states: "There is a significant and positive effect between smart manufacturing and developing lean marketing strategies." (Table 5) also shows the acceptance of the following sub-hypotheses:

- Accepting hypothesis H_{21} , as the calculated F value exceeded the tabular values at a significance level of (0.01), which proves the acceptance of this hypothesis with a confidence

Table 1: Validity and reliability test

Variable	Code	Item	C. alpha	C. V	Source
Smart manufacturing	IM	15	0.900	0.948	(Al-Bakri, 2021)
lean marketing strategies	LM	20	0.893	0.944	(Muharib, 2019)
Limit excessive marketing	LEM	4	0.751	0.866	
Minimize unnecessary processing	MUP	4	0.800	0.894	
Reduce waiting time	RWT	4	0.797	0.892	
reduce defective output	RDO	4	0.784	0.885	
Activating untapped skills	AUS	4	0.707	0.840	
Total scale		35	0.946	0.972	

percentage of (99%). This indicates the existence of an acceptable positive impact between smart manufacturing and reducing excessive marketing operations.

- Accepting hypothesis H_3 , as the calculated F value exceeded the tabular values at a significance level of (0.01), which proves the acceptance of this hypothesis with a confidence percentage of (99%). This indicates the existence of an acceptable positive impact between smart manufacturing and reducing unnecessary operations.
- Accepting hypothesis H_4 , as the calculated F value exceeded the tabular values at a significance level of (0.01), which proves the acceptance of this hypothesis with a confidence percentage of (99%). This indicates the existence of an acceptable positive impact between smart manufacturing and reducing waiting time.
- Accepting hypothesis H_5 , as the calculated F value exceeded the tabular values at a significance level of (0.01), which proves the acceptance of this hypothesis with a confidence percentage of (99%). This indicates the existence of an acceptable positive impact between smart manufacturing

and reducing waiting time. This indicates the existence of an acceptable positive effect between smart manufacturing and reducing defective outputs.

- Accepting hypothesis H_6 , as the calculated F value exceeded the tabular values at a significance level of (0.01), which proves the acceptance of this hypothesis with a confidence rate of (99%). This indicates the existence of an acceptable positive effect between smart manufacturing and activating unused skills.

5. DISCUSSION

The research results showed the impact of smart manufacturing on the development of lean marketing strategies. These results are consistent with the study (Al-Khafaji and Al-Sakri, 2022), as lean marketing aims to reduce waste and remove unnecessary steps in processes (Blair et al., 2024). These practices in lean marketing enable flexibility through continuous and systematic improvement to eliminate waste and inefficient processes (Feitosa et al., 2023). This can be achieved using smart manufacturing, as smart manufacturing relies on the introduction of modern technologies such as artificial intelligence, Internet of Things technologies, and advanced technology capable of reducing production time and costs, reducing emissions, and achieving the best results. The study (Sukhawattanakun and Supapon, 2024) confirms that smart manufacturing contributes to increasing the efficiency and independence of the manufacturing system and improves the efficiency of marketing activities. The results of this study revealed that smart manufacturing contributes to reducing excessive marketing operations, as the study (Aleksandrovna, 2023) indicates that the application of modern technology in manufacturing has a positive impact on streamlining the preparation, production, and marketing processes. The results of this research also found that there is a positive impact of smart manufacturing on reducing unnecessary treatments and reducing waiting time, thus producing on time. In this context, the study (Dubey et al., 2020) confirms that the smart manufacturing system has improved manufacturing control processes, including

Table 2: KMO and Bartlett test

KMO and Bartlett's test	IM	LM
Kaiser-Meyer-Olkin measure of sampling adequacy	0.869	0.828
Bartlett's test of sphericity		
Approx. Chi-square	497.598	754.958
Df	105	190
Significance	0.000	0.000

Table 3: Descriptive analysis

Code	N/valid	Mean	Standard deviation	C.V	Rank
IM	79	3.703	0.605	0.365	-
LM	79	3.746	0.522	0.273	-
LEM	79	3.804	0.665	0.442	2
MUP	79	3.741	0.700	0.489	3
RWT	79	3.741	0.571	0.326	4
RDO	79	3.611	0.708	0.501	5
AUS	79	3.835	0.534	0.285	1

Table 4: Correlation test

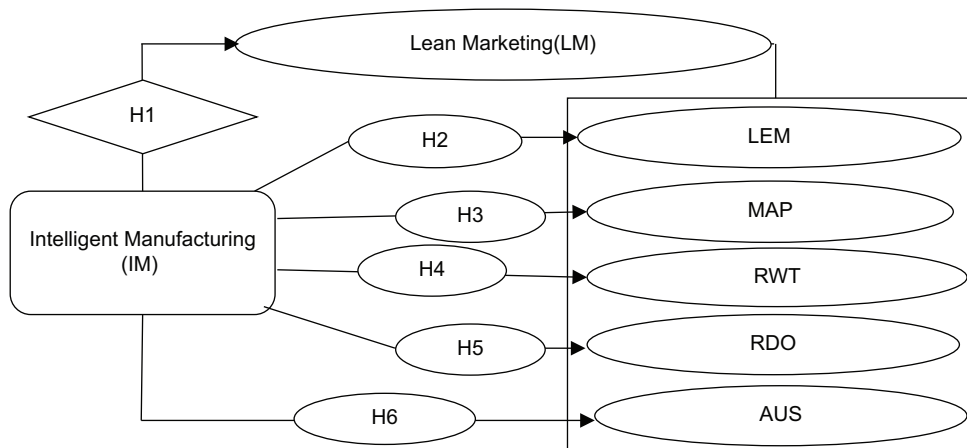
Code	AUS	RDO	RWT	MUP	LEM	LM	IM
IM	0.551**	0.887**	0.798**	0.749**	0.762**	0.922**	
LM	0.633**	0.847**	0.834**	0.882**	0.872**		
LEM	0.400**	0.665**	0.599**	0.837**			
MUP	0.375**	0.619**	0.716**				
RWT	0.450**	0.661**					
RDO	0.471**						
AUS							

** . Correlation is significant at the 0.01 level (2-tailed)

Table 5: Impact hypothesis test

H	R ²	B	A	T-test	F-test	Significance	Result
H ₁	0.849	0.922	0.797	20.947	438.761	0.000	Supported
H ₂	0.575	0.838	0.762	10.323	106.560	0.000	Supported
H ₃	0.555	0.867	0.749	9.921	98.421	0.000	Supported
H ₄	0.632	0.753	0.798	11.607	134.732	0.000	Supported
H ₅	0.783	1.038	0.887	16.827	283.161	0.000	Supported
H ₆	0.295	0.487	0.551	5.794	33.567	0.000	Supported

Figure 1: Search model. IM: Smart manufacturing, LM: Lean marketing, LEM: Limit excessive marketing, MUP: Minimize unnecessary processing, RWT: Reduce waiting time, RDO: Reduce defective output, AUS: Activating untapped skills



planning the schedule for diagnosis, predictive supply, and evaluation, and reduced production and waiting time. The results of this study revealed that smart manufacturing has contributed significantly to reducing defective products, reducing damage, reducing emissions, reducing environmental damage, and diagnosing and treating the causes of failure (Ren et al., 2024). This study also found that there is an impact of smart manufacturing in activating unused skills, as artificial intelligence tools can self-learn and exploit tools, and the technological environment supports innovation and encourages development (Evjemo et al., 2020).

6. CONCLUSION

The results of this research showed that smart manufacturing positively affects the development of lean marketing strategies, as well as the existence of a significant relationship and correlation between smart manufacturing and lean marketing dimensions and that the combination of smart manufacturing and lean marketing contributes to improving the operational and marketing performance of the manufacturing organization, enabling it to quickly adapt to market changes and meet the growing needs of customers with high efficiency. The application of smart manufacturing strategies along with lean marketing leads to building a strong competitive advantage for companies, as they can provide innovative products and services more quickly while reducing waste and production costs. The integration of smart technologies and flexible marketing methods also helps accelerate the innovation process, whether in developing new products or improving processes, which enables companies to stay at the forefront of the competition. However, the application of the integration between smart manufacturing and lean marketing faces challenges related to technical infrastructure, organizational change, and the required human skills. Therefore, companies need effective strategies to manage these challenges and ensure a smooth transition to these strategies. The results of this research also showed that the Baghdad Sewing Factory (Tent Factory) relies on artificial intelligence and modern technological techniques in sewing tents for different customers and that the integration between smart

manufacturing and lean marketing can contribute significantly to improving the customer experience and increasing their satisfaction, by providing products and services that better suit their needs and with higher quality.

This research provides some recommendations for the tent factory and other companies to invest in smart manufacturing technologies, such as artificial intelligence and the Internet of Things, and integrate them with lean marketing strategies to ensure increased efficiency and flexibility in responding to market requirements. It is necessary to focus on developing the skills of its employees in both smart manufacturing and lean marketing, including training on the use of modern technological tools and flexible marketing strategies, to ensure maximum benefit from these systems. Since the implementation of smart manufacturing and lean marketing requires structural and organizational changes, it is important to have effective change management strategies, including the participation of different teams in the decision-making process and guiding them during the transformation period. The study also recommends the need to enhance communication and cooperation between production teams and marketing teams within institutions, to ensure the implementation of smart manufacturing and lean marketing strategies harmoniously, and to achieve common goals efficiently. And to benefit from the available data from smart manufacturing operations, and analyze them to guide lean marketing strategies more accurately, which enhances the ability to understand customer expectations and provide products and services that meet their needs. This study recommends conducting more studies and expanding the scope to include various sectors and industries. It is useful to conduct future studies that include various industrial sectors and companies of different sizes to understand how smart manufacturing and lean marketing affect different business environments. It is also suggested to conduct field and experimental studies based on collecting real data from companies that have adopted these strategies, to analyze their actual impact on operational and marketing performance. It would be good to conduct a study that explores the impact of cultural and organizational factors on the success of smart manufacturing implementation, as well as a study that links lean

marketing strategies with artificial intelligence technologies and their impact on understanding customer needs and targeting the market, and how to adapt these strategies to different business environments. Future research can explore how the integration of smart manufacturing and lean marketing can contribute to enhancing environmental sustainability by reducing waste and increasing resource utilization efficiency.

7. ACKNOWLEDGMENT

We would like to thank Baghdad Sewing Factory (Tent Factory) for providing us with the information required to carry out the study.

REFERENCES

- Al Khazraje, M., Sideeq, S. (2024), The role of wise leadership in managing strategic ignorance in the public sector. *Administration and Public Management Review*, 43(43), 120-137.
- Al Khazraje, M.E. (2024), The role of adopting green strategies in the development of eco-friendly products. *Management Research and Practice*, 16(3), 71-83.
- Al-Awadi, A., Tufan, M. (2023), The role of production process reengineering in achieving smart manufacturing. *Iraqi Journal of Administrative Sciences*, 19(76), 273-295
- Al-Bakri, F.H. (2021), Hybrid Manufacturing and its Impact on Enhancing Organizational Excellence, the Interactive Role of Smart Production, Unpublished Master's Thesis. College of Administration and Economics, University of Karbala, Iraq.
- Aldrini, J., Chihi, I., Sidhom, L. (2024), Fault diagnosis and self-healing for smart manufacturing: A review. *Journal of Intelligent Manufacturing*, 35(6), 2441-2473.
- Aleksandrovna, P.A. (2023), Agile Marketing as a Factor of Firm Performance: Empirical Study of Russian Companies. Russia: St. Petersburg University Graduate School of Management Master.
- Al-Hamdani, R., Al-Salem, S. (2023), Testing the mediating role of marketing intelligence in the relationship between lean marketing and customer value. *Journal of Business Economics for Applied Research*, 4(3), 155-175.
- Al-Hassoun, A. (2021), The impact of continuous improvement dimensions on achieving smart manufacturing an analytical study of the opinions of a sample of employees of Al-Waha soft drinks company. *Journal of the College of Administration and Economics for Economic, Administrative and Financial Studies*, 13(3), 108-131.
- Ali, H.H., Khalil, S.S., Khalil, R.J. (2021), The role of lean marketing in achieving sustainable competitive advantage: An analytical study at Al-Mosul dairy manufactory. *Journal of Techniques*, 3(2), 61-72.
- Ali, H.M.A.K.A., Obaid, H. (2024), Using artificial intelligence techniques to improve lean marketing processes analytical study of the opinions of a sample of specialists in the artificial intelligence research center at the universities of Baghdad and Al-Mustaqbal. *Journal of Studies in Humanities and Educational Sciences*, 2(6A).
- Al-Janabi, A.A., Al-Jabouri, M. (2020), Lean marketing and its role in enhancing the bank's marketing efficiency: An analytical survey study of the opinions of a sample of administrative leaders in private banks in Karbala governorate. *Journal of Administration and Economics*, 9 (36): 68-86
- Al-Khafaji, Hakim, and Al-Sakri, Hussein (2022) Human Resources Flexibility and Its Impact on Improving Lean Marketing, *Journal of the Islamic University College*, 1(67): 143-189
- Al-Khafaji, Hakim, and Al-Sakri, Hussein (2022) Human Resources Flexibility and Its Impact on Improving Lean Marketing, *Journal of the Islamic University College*, 1(67): 143-189.
- Al-Khazraje, M.E.B., Zahra, A.H.A. (2023), Spiritual leadership's role in promoting social responsibility. *Iraqi Journal for Administrative Sciences*, 19(77), 250-75.
- Al-Qoutji, B., Al-Mulla Hassan, M. (2021), Marketing control and its impact on organizations' adoption of lean marketing: An analytical study of the opinions of a sample of workers at Mosul Iron and steel company. *Al-Muthanna Journal of Administrative and Economic Sciences*, 11(2), 95-111.
- Al-Taie, H., Al-Samman, T. (2022), The role of smart manufacturing technology in sustainable marketing, a survey study in the general company for construction industries in Baghdad. *Journal of Business Economics for Applied Research*, 2(2), 155-175
- Arcidiacono, F., Ancarani, A., Di Mauro, C., Schupp, F. (2023), Linking competitive priorities, smart manufacturing advancement, and organizational microfoundations. *International Journal of Operations and Production Management*, 43(9), 1387-1408.
- Blair, G., Betts, P., Conway, T., Hyde, M., Pagano, R. (2024), Delivering agile marketing projects: A view from practice. *Apex Journal of Business and Management*, 2(1), 49-62.
- Dubey, R., Gunasekaran, A., Childe, S.J., Bryde, D.J., Giannakis, M., Foropon, C., Roubaud, D., Hazen, B.T. (2020), Big data analytics and artificial intelligence pathway to operational performance under the effects of entrepreneurial orientation and environmental dynamism: A study of manufacturing organizations. *International Journal of Production Economics*, 226, 107599.
- Evjemo, L.D., Gjerstad, T., Grøtli, E.I., Sziebig, G. (2020), Trends in smart manufacturing: Role of humans and industrial robots in smart factories. *Current Robotics Reports*, 1, 35-41.
- Fakhry, N.H., Alkhazraje, M.E., Saleh, M.R. (2024), Job immersion and its role in reducing organizational obesity through job compatibility. *Management Dynamics in the Knowledge Economy*, 12(2), 166-183.
- Feitosa, E.J., Dos Reis, E.R.P., Negri, M.A.E. (2023), Agile marketing: Uma estratégia mercadológica além do 4.0. *Brazilian Journal of Development*, 9(3), 9936-9949]
- Hair, J., Hult, T., Ringle, C., Sarstedt, M. (2017), *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Los Angeles: Sage.
- Hamoudi, W.H., Daniel, R.G., Abdul Fattah, A.E., Najmaldeen, N.A. (2022) Lean manufacturing and its role in achieving green marketing: A survey study in Mosul Dairy Factory. *Rafidain Development*, 41(135):178-199.
- Hassan, K. A. Z., & Al-Jubouri, N. K. I. (2023). Ethical Leadership and Its Impact on Sustainable Performance—An Exploratory Study of the Opinions of Employees at Al-Mustaqbal University. *Futurity Economics&Law*, 3(4), 135-152.]
- Hawas, Thamer Akab Hawas (2020) The Extent of Availability of Smart Manufacturing Pillars A Survey Study of the Opinions of a Sample of Employees at Crown Beit Company, *Tikrit Journal of Administrative and Economic Sciences*, 16(52) Part 3: 30-49
- Hawas, Thamer, and Yeridi, Najah (2021). The Role of Smart Manufacturing System in On-Time Delivery A Field Study in Kronje Company, *Tikrit Journal of Administrative and Economic Sciences*, Volume 17(54) Part 2: 177-189
- Ismail, I.K. (2023), The mediating role of process flexibility in the relationship between smart manufacturing and new product design processes. *Journal of Baghdad College of Economics University*, (71), 105-122.
- Katara, S. (2022), Agile marketing is a key driver to increasing operational efficiencies and speed to market. *International Journal of Business Administration*, 13(2), 92-101.
- Kessler, M., Arlinghaus, J.C. (2022), A framework for human-centered production planning and control in smart manufacturing. *Journal of*

- Manufacturing Systems, 65, 220-232.
- Leng, J., Wang, D., Shen, W., Li, X., Liu, Q., Chen, X. (2021), Digital twins-based smart manufacturing system design in Industry 4.0: A review. *Journal of Manufacturing Systems*, 60, 119-137.
- Ma, S., Zhang, Y., Liu, Y., Yang, H., Lv, J., Ren, S. (2020), Data-driven sustainable intelligent manufacturing based on demand response for energy-intensive industries. *Journal of Cleaner Production*, 274, 123155.
- Meng, Y., Yang, Y., Chung, H., Lee, P.H., Shao, C. (2018), Enhancing sustainability and energy efficiency in smart factories: A review. *Sustainability*, 10(12), 4779.
- Moi, L., Cabiddu, F. (2021), An agile marketing capability maturity framework. *Tourism Management*, 86, 104347.
- Mourtzis, D., Angelopoulos, J., Panopoulos, N. (2021), Smart manufacturing and tactile internet based on 5G in industry 4.0: Challenges, applications and new trends. *Electronics*, 10(24), 3175.
- Muharib, H.T. (2019), Strategic Change Readiness as an Intervening Variable between Human Resources Flexibility and Lean Marketing. Unpublished Master's Thesis. College of Administration and Economics. Iraq: University of Kufa.
- Othman, U., & Yang, E. (2023). Human-robot collaborations in smart manufacturing environments: review and outlook. *Sensors*, 23(12), 5663.
- Qu, Y.J., Ming, X.G., Liu, Z.W., Zhang, X.Y., Hou, Z.T. (2019), Smart manufacturing systems: State of the art and future trends. *The International Journal of Advanced Manufacturing Technology*, 103, 3751-3768.
- Rahimi, S. (2020), An overview of agile marketing and its application. *Journal of Intelligent Marketing Management*, 1(5), 81-93.
- Raouf, R.A., Hamdi, S.H. (2013), Lean marketing dimensions and its role in enhancing marketing efficiency - a case study in Asiacele communications company in Nineveh governorate. *Rafidain Development*, 35(114), 155-170.
- Ren, L., Dong, J., Liu, S., Zhang, L., & Wang, L. (2024). Embodied intelligence toward future smart manufacturing in the era of AI foundation model. *IEEE/ASME transactions on mechatronics*, 30(4), 2632-2642.
- Sachdeva, P., & Kumar, D. (2022). Strategic marketing: Agile marketing developments. *Journal of Positive School Psychology*, 6(5), 6575-6589.
- Salam, A., Mahmoud, S.M. (2022), The possibility of establishing the pillars of smart manufacturing pillars a case study in the general company for automotive and equipment industry - babylon battery factory. *Journal of Business Economics for Applied Research*, 3(5), 389-405.
- Samaka, A. M. A., & Kazem, M. A. H. (2022). Agile Marketing Strategy In Banks and Its Impact On Enhancing Customer Loyalty: An Analytical Study. *Journal of Positive School Psychology*, 6(5) 7251-7265.
- Sukhawatthanakun, K., Supapon, S. (2024), Agile marketing competency and innovation capability meditating on new product management for industrial business development guidelines. *International Journal of Product Lifecycle Management*, 15(3), 259-283.
- Tantawi, K.H., Fidan, I., Musa, Y., Tantawy, A. (2023), Smart manufacturing: Post-pandemic and future trends. In: *Applied AI and Multimedia Technologies for Smart Manufacturing and CPS Applications*. Hershey: IGI Global. p278-300.
- Vallejo-Chávez, L.M., Tapia-Bonifaz, A.G., Guadalupe-Arias, S.E., Tapia-Segura, S. G., Flor-Cantos, J.C. (2023), Lean manufacturing and sustainable development in the urban markets of the city of Riobamba, Province Chimborazo, Ecuador. *Journal of Namibian Studies: History Politics Culture*, 33, 2675-2689.
- Wang, J., & Hsu, C. C. (2021). A topic-based patent analytics approach for exploring technological trends in smart manufacturing. *Journal of Manufacturing Technology Management*, 32(1), 110-135.
- Yan, W., Wang, J., Lu, S., Zhou, M., & Peng, X. (2023). A review of real-time fault diagnosis methods for industrial smart manufacturing. *Processes*, 11(2), 369.