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THE IMPACT OF INTERNET OF THINGS ON THE INTEGRATION OF COMPETITIVE ADVANTAGE IN THE VALUE CHAIN: FIELD STUDY OF FOREIGN-LISTED COMPANIES IN ALGERIA

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ABSTRACT

In an era of digital economy, companies are increasingly investing in applications and solutions that integrate their processes, machines, employees, and even products into a single integrated network for data collection and analysis, evaluation of company development and improved performance ,to examine the impact of IoT on companies we have used the value chain model, which is particularly important when paying attention to areas of companies that have a key role in creating value for customers and since the IoT's primary impact is perceived in value creation processes,it has so far had the greatest transformative effect in this area the model can be considered appropriate for the study,the aim of our research is to discover how foreign shareholding companies in Algeria are keeping up with the digital economy and what IoT applications they use to support their operations,And what critical problems you face during adaptation, we sent an electronic questionnaire to manufacturers and logistics companies to verify the IoT applications they use and the problems they face and we received 30 answers that we can evaluate, in our research, we found that real-time data dissemination across companies given the availability of appropriate analytical applications and methods can have a significant impact on the entire company, in the case of physical cyber system (CPS) and Big Data Analysis (BDA), where companies evaluating uses it as having a higher level of logistics and more efficient operations with its partners, improved cooperation between logistics functions, higher financial performance and competitiveness, more efficient production processes, better productivity and economies of scale may lead to increased economic sustainability in the future,moreover, we found that companies have started the path of digital development and have already started investments of this kind.

KEYWORDS

Internet of Things, Integration, Competitive Advantage, Value Chain, Algeria

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1. Introduction

Nowadays, the Internet of Things (IoT) is causing a revolution through its innovative and qualitative nature. The quality of these changes is evident in the fact that the entire production process is now managed and monitored in an integrated manner and designed to be flexible in order to remain competitive in a globalized environment. Manufacturing companies are required to continuously develop their production systems and adapt to changing demands. This, in turn, has a significant impact on industries and markets, as well as on the entire product life cycle. It provides a new way of producing and conducting business, enabling process improvement and enhancing companies' competitive advantage.

Although computers, automation, and robotics have been available for decades, the opportunities offered by the Internet of Things provide increasingly cost-effective solutions such as monitoring activities, operating machinery, materials, workers, and even the products themselves. It also allows for data collection, analysis, and utilization in making informed decisions—now a competitive factor in integrating competitive advantage within companies’ value chains—leading to a smart manufacturing environment.

Based on this, the research problem addressed in this study can be formulated as follows: **What is the impact of the Internet of Things on the integration of competitive advantage within the value chain of foreign-invested companies in Algeria?**

- Study Hypotheses

To simplify the examination of the research problem, a set of hypotheses is formulated, covering the fundamental aspects and detailing the study variables. These hypotheses serve as provisional answers to the research question posed.

Main Hypothesis:

There is a positive impact relationship between the Internet of Things and the integration of competitive advantage within the value chain. This is divided into:

Sub-hypothesis 1: There is a positive impact relationship between the Internet of Things and the integration of internal operations.

Sub-hypothesis 2: There is a positive impact relationship between the Internet of Things and supplier integration.

Sub-hypothesis 3: There is a positive impact relationship between the Internet of Things and customer integration.

Sub-hypothesis 4: There is a positive relationship between the integration of internal operations and competitive advantage within the value chain.

Sub-hypothesis 5: There is a positive relationship between supplier integration and competitive advantage within the value chain.

Sub-hypothesis 6: There is a positive relationship between customer integration and competitive advantage within the value chain.

- Significance of the Study:

The Internet of Things (IoT) is a topic related to advanced technology, and it has recently gained importance due to its potential impact on our daily lives and on businesses in the future. It is expected that, in the near future, our cars, consumer products, industries, and various other everyday items will become connected through the Internet of Things. This combination of connected objects with powerful data analytics capabilities can serve as a reliable source for intelligent decision-making, potentially transforming the way companies operate and even the way people live in the future.

- Objectives of the Study:

The primary objective of this study is to contribute to the current understanding by emphasizing that the Internet of Things (IoT) is a fundamental source of excellence for leading companies and a driver of competitive advantage. In addition, the study aims to:

- Gain a comprehensive understanding of the theoretical concepts related to the Internet of Things;
- Identify the level of IoT implementation in companies;
- Highlight the impact of the Internet of Things on the integration of competitive advantage within the value chain.

- Research Methodology:

This study follows a clear methodology that supports the investigation and diagnosis of the research problem by adhering to a set of systematic rules and procedures in order to reach relevant conclusions. Therefore, we adopted the descriptive approach to describe certain aspects related to the study variables, such as highlighting key definitions and fundamental concepts related to the topic. Additionally, the analytical approach was used to analyze the nature of the relationships and the various effects among the study's axes and variables, and to test the proposed hypotheses.

Data and information were collected through a questionnaire, and then categorized and analyzed using several statistical methods. Analytical tools such as Smart PLS and SPSS software will be used in the subsequent stages of the study.

2. Theoretical Framework

2.1. The Internet of Things: Origins and Evolution

2.1.1. The Concept of the Internet of Things

The Internet of Things (IoT) is both a new and old term. It was first mentioned by British technology pioneer **Kevin Ashton** in 1999 during a presentation for **Procter & Gamble (P&G)**, aiming to attract the attention of the company's senior management. He titled his presentation *"The Internet of Things"*. Ashton is one of the founders of the **Auto-ID Center** at the **Massachusetts Institute of Technology (MIT)**, and he used the term to link the idea of **Radio Frequency Identification (RFID)** technology to the internet for delivering new services (Ashton, 2009).

Since then, the use of the term has flourished, and major companies have projected a significant rise in IoT. According to studies and forecasts, the number of connected objects worldwide was expected to increase thirtyfold between 2013 and 2020. By 2020, it was projected that there would be **27 billion connected devices** (EMC, 2014).

The core concept of the Internet of Things is **connecting objects together**, thereby enabling these objects to communicate with each other, as well as allowing people to interact more seamlessly with one another. In this research paper, we adopt the definition of IoT proposed by the **ITU's Telecommunication Standardization Sector**, a United Nations agency specialized in information and communication technologies (ICTs):

"A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies." (ITU, 2012)

Connecting the physical world to the virtual world and applying this concept to all objects opens up new possibilities — enabling access to **anything, anytime, from anywhere**. However, offering new possibilities also introduces new threats, security risks, and exposes vulnerabilities in a yet-to-be-fully-explored world where everything is interconnected.

In this context:

- **Physical world objects** are tangible, real-world items. From the IoT perspective, we can sense, control, and communicate with these objects.
- **Virtual world objects** are digital items that can be stored, accessed, and processed electronically.

It is difficult to define the Internet of Things precisely, as it describes a world where **any object can be connected and interact intelligently** with a **global information infrastructure**, enabling advanced services by linking physical and virtual things through current and evolving ICTs in an interoperable way.

From this perspective, the Internet of Things can be defined as a **network of smart objects**—such as home appliances, mobile phones, laptops, etc.—processed through a specialized system and connected to the internet via a unified framework.

2.1.2. Characteristics of the Internet of Things

The Internet of Things (IoT) represents a futuristic technology and a promising market for business owners. Below are some of its common characteristics:

- Data Collection and Intelligent Processing:

IoT enables the widespread deployment of sensors and the rapid and efficient collection of data, forming a new mode of cooperation between connected devices. The intelligent processing of the collected data is one of the key features of IoT.

- Interconnectivity:

IoT has the capability to connect anything—whether physical or virtual—through the support of information and communication infrastructure. This infrastructure refers to the communication system's architecture through which broadcasting and telecommunication services are operated.

- Object-Related Services:

IoT is capable of providing services related to physical objects, while adhering to their limitations—such as ensuring privacy protection and maintaining semantic consistency between physical and virtual objects.

- Heterogeneity:

Devices in the IoT ecosystem are heterogeneous, operating on different platforms and networks. Despite their differences, they can interact with other devices or service platforms across various networks.

- Dynamic Changes:

The state of devices in IoT changes dynamically. For example, devices may be turned on or off, connected or disconnected, and their context-such as location and speed-may also change. Additionally, the number of devices can vary dynamically.

- Massive Scale:

The number of devices that need to be managed and that communicate with each other is expected to far exceed the number of devices currently connected to the internet.

- Safety:

This includes the protection of our personal data, physical safety, and securing both the networks and the data being transmitted. It requires the establishment of a comprehensive security model.

- Connectivity:

Connectivity ensures access to and compatibility with the network. Compatibility allows for the shared ability to consume and generate data (Ovidiu & Peter, 2014). Most importantly, it relates to the management and interpretation of the data generated for application purposes, including data semantics and efficient processing.

2.1.3. Fields of Application of the Internet of Things:

The applications of the Internet of Things are numerous and diverse across all areas of daily life. All IoT applications developed so far fall within the following fields:

- Smart Cities:

The Internet of Things plays a vital role in enhancing the intelligence of cities. It includes numerous applications such as monitoring the availability of parking spaces in urban areas, detecting vibrations and physical conditions in buildings and bridges, and monitoring noise levels in sensitive areas of the city, among others.

- Smart Agriculture and Smart Water Management:

IoT can help improve and optimize agricultural practices by monitoring soil moisture and controlling climate conditions to maximize the quantity and quality of fruit and vegetable production. In terms of water management, IoT can be used to assess the suitability of river and seawater for agricultural use and for safe drinking purposes, among other applications.

- Retail and Logistics:

The application of IoT in value chain management offers many advantages, including monitoring storage conditions throughout the supply chain, tracking products for processing purposes, and enabling payments based on location or public transportation activity duration, among others.

- Healthcare:

Many benefits provided by IoT technologies are categorized under healthcare, including monitoring staff and patients, identifying individuals, and collecting automatic data about them. It also involves tracking the flow of patient information to improve workflow in hospitals and maintaining comprehensive, up-to-date electronic medical records.

- Security and Emergency Response:

IoT technologies are increasingly used in the fields of security and emergency management, for example, in monitoring critical infrastructure to prevent collapses and corrosion. They are also used to measure radiation levels in nuclear power plants for leak detection, as well as to detect gas levels and leaks in industrial environments. (Pokodi & Bhuvaneswari, 2017)

2.2. The Nature of the Value Chain

2.2.1. The Concept of Porter's Value Chain Model

The digital economy has a broad impact on entire companies. Therefore, it is essential to understand how businesses can take advantage of the opportunities offered by digitalization. To provide a structured approach to this, the **Value Chain Model** was needed, as it represents the core process through which companies create value for the customer.

Digitalization primarily affects the different elements involved in **value creation**, and initially, it impacts **production** more than any other aspect. However, one should not overlook the activities that support value creation and how these can benefit from the achievements of the digital industry.

The value chain represents the structure a company uses to understand where its costs are located and to identify multiple tools used to facilitate and implement business strategy at the operational level. (Hitt, Ireland, Duane, Hoskisson, & Robert, 2001). It is also used to identify key resources and processes, which represent the strengths and logic that need improvement, as well as the opportunities to develop a **competitive advantage**. (Harrison & John, 1998)

According to **Porter's Value Chain** concept (Porter, 1985), a company's competitive advantage cannot be viewed in general terms; rather, it is essential to understand the **internal structure** of the company—specifically, how individual business activities contribute to delivering a product or service either at a lower cost or with superior quality compared to competitors.

One possible type of value chain model is the organization of activities within companies in a way that helps identify the **source of competitive advantage**. This applies not only to the value chains of companies in different industries but also to the different value chains created by each company operating in the same industry. The structure of these chains depends on the company's strategy, how it implements that strategy, and the company's organizational traditions.

The **value created by the chain** is the worth that the product (or service) holds for the buyer. Therefore, the price must significantly exceed the cost—this is the foundation of a company's survival. Moreover, understanding the **value-based approach**, i.e., understanding customer needs, is the cornerstone of a company's strategy.

2.2.2. Components of the Value Chain

From a strategic perspective, the value chain approach breaks down the company into a series of activities responsible for creating value. These activities are categorized into **primary activities** and **support activities**, as follows:

Primary Activities: These consist of five key activities:

- **Inbound Logistics:** These are activities related to receiving, storing, and distributing the inputs necessary for the product. They include materials handling, warehousing, and inventory control.
- **Operations:** These activities are related to transforming inputs into final products. They include machine operations, assembly, packaging, and equipment maintenance.
- **Outbound Logistics:** These are activities concerned with collecting, storing, and distributing the final product to buyers. They include warehousing of finished goods, materials handling, delivery operations, order fulfillment, and scheduling.
- **Marketing and Sales:** These are activities related to providing the means by which customers can purchase the product and encouraging them to do so. They include advertising, promotion, sales force, public relations, etc.
- **Service:** These activities are related to providing services that support or maintain the product's value. They include after-sales services such as installation, repair, training, spare parts, and product adjustments.

Support Activities: These include four key activities:

- **Firm Infrastructure:** This includes activities such as general management, accounting, legal affairs, finance, strategic planning, and all other foundational and supportive functions essential for operating the entire value chain.
- **Human Resource Management:** These are activities necessary for recruiting, training, and developing personnel. This includes all activities related to human resources, which are integrated throughout the entire value chain.
- **Technology Development:** These activities relate to product design as well as the improvement of processes across the value chain. They include the knowledge, procedures, and technological inputs required for each value activity.
- **Procurement:** These are activities related to acquiring the inputs needed for the business, whether raw materials, services, or machinery. This function spans the entire value chain, as it supports each activity where purchasing is involved. (Michael, 1999)

2.2.3. Integration in the Value Chain

In today's dynamic and competitive business environment, it is value chains—not individual companies—that compete with one another. Increasing integration within the value chain enhances sustainable competitive advantage and serves as a mechanism for improving company performance.

Value chain integration can be defined as the collaborative and joint management among firms—both within and across organizational boundaries—concerning strategic, tactical, and operational business processes to achieve efficient flows of products, information, and finances. The goal is to deliver maximum value to the end customer at the lowest cost and with the required speed. (Alfalla, Medina, & Dey, 2013)

As a topic that bridges knowledge in information systems with the literature on value chain management, integration has been viewed as the **digital interconnection of business processes** within the company and between companies. This includes suppliers at the upstream stage and customers at the downstream stage.

Furthermore, many researchers consider that value chain integration involves **three intermediary variables**:

- **Internal process integration**
- **Supplier integration** at the early stages of production
- **Customer integration** at the final stages. (Ataseven & Nair, 2017)

Internal integration refers to the breakdown of cross-functional barriers within the company through synchronized processes. This is achieved by facilitating real-time information sharing across business functions, along with strategic collaboration and coordination to enhance performance.

Supplier and customer integration refers to the sharing of strategic information, joint planning, and cooperation between the focal company and its key suppliers and downstream customers in managing synchronized operations. (Zhao, Huo, Selen, & J)

Supplier integration involves collaboration between the focal company and its suppliers in managing inter-organizational business processes. Customer integration, on the other hand, enables a deeper understanding of market expectations and allows for more accurate and faster responses to customer requirements. Value chain integration has increasingly become a significant area of academic research and practical application. In other words, companies have begun to ask how they can integrate and optimize their activities, processes, and the flow of materials and information—both internally and with their partners—to fully benefit from the concepts and practices of value chain management.

To achieve this, it is essential for companies to integrate efficiently with their suppliers, customers, and partners. Various research findings indicate that a higher level of integration with suppliers and customers in the value chain results in greater advantages.

Stevens is recognized as one of the pioneering researchers in value chain integration. He identified **four stages** of value chain integration:

- The first stage is characterized by fragmented processes within the company.
- The second stage is limited to integration between adjacent functions—for example, purchasing and materials control.
- The third stage involves **internal integration**, requiring comprehensive planning within the company.
- The final stage represents true **value chain integration**, including sourcing activities with suppliers and manufacturers. (Stevens, 1989)

In another study, integration within the context of the value chain was categorized into **six distinct types**:

1. Customer integration
2. Internal integration
3. Supplier integration (materials and services)
4. Technology and planning integration
5. Measurement integration
6. Relationship integration (Bowerson & Stank, 2001)

Frohlich & Westbrook highlighted the importance of the strategic decision regarding the degree of integration between companies in value chains within industries. They introduced the concept of "integration arcs," which serves as a starting point for the literature on value chain integration. Depending on the complexity of the market, industries and companies may decide to engage in relatively minimal or greater integration with suppliers and customers.

In their study, they examined the impact of value chain integration levels on performance and categorized value chain integration into five categories: inward, company perimeter, supplier, customer, and outward. These categories were based on the density of the company's integration with customers and supplier orientations. They examined performance differences among these five categories. As a result, they found that companies that leaned outward—defined as having the most comprehensive integration in their value chains—performed better across various metrics compared to companies in other categories (Frohlich & Westbrook, 2001).

If the need for joint operational activities is accepted, the strategic issue becomes one of direction and degree. This means deciding which direction to take (toward customers or toward suppliers) and to what arc (degree of integration), and whether this activity should be joint. By considering this pair of decisions as key dimensions to represent the strategic stance, they can be graphically represented as an arc with the sector's direction indicating whether the company leans toward integration with suppliers or customers. The arc's degree determines the level of integration.

3.Field Study

3.1.StudySample: The survey questionnaire was sent electronically to a group of company owners. English was used as the unified language of the questionnaire regardless of their nationalities. The participants were technical experts in various economic fields who either work with the Internet of Things (IoT) platform or are exploring the adoption of this technology within their companies. A total of 30 responses that were suitable for statistical analysis were selected.

3.2.StudyVariables: In light of the study's objectives and hypotheses, a five-point Likert scale was used to measure the respondents' opinions regarding the research variables. The scale ranges from a weight of (5) for "Strongly Agree" to a weight of (1) for "Strongly Disagree."

3.3. Reliability and Validity Test of the Scale: Regarding the reliability of the study instrument—which refers to the internal consistency among the items of the tool, and the possibility of obtaining the same or similar results if the study were to be repeated on a different sample at different times—it was verified using a set of measures, as shown in the following table:

Table 1. Cronbach's Alpha Reliability Coefficients, Composite Reliability, and Discriminant Validity Tests for the Study Constructs

Dimensions	N° of statements	Internet of Things	Internal Process Integration	Supplier Integration	Customer Integration	Competitive Advantage in the Value Chain	Cr. Alpha	CR	AVE
Internet of Things	9	**0.7018**					0.88	0.81	0.50
Internal Process Integration	9	0.0501	**0.7502**				0.94	0.83	0.56
Supplier Integration	8	0.2548	0.3245	**0.7458**			0.97	0.85	0.54
Customer Integration	9	0.0345	0.2015	0.2516	**0.7485**		0.89	0.86	0.65
Competitive Advantage in the Value Chain	14	0.5927	0.0022	0.5321	0.1548	**0.7953**	0.90	0.76	0.61

Source: Prepared by the researcher based on the outputs of Smart PLS.

From the table above, we notice that all Cronbach's Alpha values exceeded 0.8, with the overall value of this coefficient being 0.91. This indicates that the measurement tool has good reliability and high stability if the tool is re-employed under the same conditions. It also demonstrates a high internal consistency between the statements and the constructs it forms. Additionally, the Composite Reliability (CR) is also an indicator of construct reliability, and composite reliability values exceeding 0.7 indicate a reliable and homogeneous construct. Furthermore, the Average Variance Extracted (AVE) for each construct exceeds the minimum value of 0.50, which indicates that the constructs have adequate convergent validity. Convergent validity was assessed by comparing the relationship between the construct and the square root of the (AVE). The square root of the (AVE) for all constructs shown along the diagonal is greater than the correlation between any pair of constructs, indicating that the model meets the measurement requirements for convergent validity.

3.4. Study Sample Distribution:

The sample was distributed according to the variables (type of activity, years of experience, nationality, types of Internet of Things applications used in the company, and critical issues faced by company owners in implementing the Internet of Things), as outlined below:

Table 2. Study of the Distribution Characteristics of the Sample According to (Type of Activity, Years of Experience, Nationality, IoT Tools)

Variables	Frequency	Percentage %
Type of Activity		
Household Appliances	3	10
Food Products	4	13.33
Pharmaceuticals	2	6.67
Automation	2	6.67
Software	4	13.33
Security and Safety	4	13.33
Telecommunications	5	16.67
Logistics Services	6	20
Years of Experience		
Less than two years	15	50
From 2 to 5 years	9	30
More than 5 years	6	20
Nationality		
Chinese	17	56.66
Spanish	8	26.67
German	2	6.67
Italian	3	10
Internet of Things (IoT) Applications		
Cyber-Physical System (CPS)	10	33.33
Big Data Analytics (BDA)	8	26.67
Cloud Computing (CC)	3	10
Robotic Arms (RA)	5	16.67
Digital Supply Chain (DSC)	2	10
Radio Frequency Identification (RFID)	1	3.33
Total Sum of the Sample	**30**	**100**

Source: Prepared by the researcher based on the outputs of SPSS.

The previous table illustrates the distribution of the study sample according to the type of activity, i.e., the areas of their business activities, which we classified based on the most prominent sectors available in the Internet of Things (IoT) environment. It can be observed that the majority of the sample belong to the logistics sector, with a percentage of 20%, followed by the telecommunications sector at 16.67%. These two activity types are the most common and widespread among the sample. Following them are the food products, software, and security and safety sectors, each with a percentage of 13.33%, respectively. As for household appliances, they account for around 10%, while the remaining activity types are distributed between the pharmaceutical industry and automation, each with an equal percentage of 6.67%.

Regarding years of experience, the percentages are quite similar across all experience categories, except for the "less than two years" category, which constitutes 15%. The highest percentage is found in the "2-5 years" category, at 30%, followed by the "more than 5 years" category with 20%. In general, the majority of the sample have an average experience of around five years, which leads us to conclude that most of the study participants possess a moderate level of experience.

As for the nationality of the study sample, the majority of respondents are Chinese, with a percentage of 56.66%, followed by Spanish at 26.67%. Italians and Germans make up the remaining portion, with percentages ranging from 10% to 6.67%.

When analyzing the Internet of Things applications used, the table reveals that Cyber-Physical Systems (CPS) is the most widely used tool, with a percentage of 30%, especially in the industrial sector. CPS can also rely on Big Data Analytics (BDA) at 26.67%, despite the higher usage rate of CPS, which allows companies to combine the physical and virtual worlds. However, the study sample relies on BDA, which helps companies, for instance, in production scheduling, maintenance planning, and avoiding production disruptions. This indicates that these companies enjoy higher logistics service levels and more efficient operations with their partners.

Robotic Arms (RA) are used at a rate of 16.67% in 5 companies, due to their ability to collaborate with humans hand-in-hand. Cloud Computing (CC) and Digital Supply Chain (DSC) are used at a rate of 10% each in 6 companies. This is due to the ease of storing various files in cloud computing and the ability to process data and create backups. As for the Digital Supply Chain, it breaks down all barriers by integrating key business processes for all parties, starting with suppliers, passing through the factory, and reaching the customer in a unified system.

Finally, the Radio Frequency Identification (RFID) system is used at 3.33% for remote control of goods and products and automated asset management.

Through the opinions of the respondents, it became evident that the major challenges hindering or delaying the implementation of the Internet of Things include the lack of a clear digital strategy in value creation processes (production and logistics), the lack of executive support for IoT adoption due to fears of investment risks, loss of intellectual property control, failure to develop and analyze infrastructure data, data security issues, and uncertainties regarding encryption. Cultural problems also play a role, such as negative judgments about the company's capabilities and lack of trust in them. Moreover, there is a shortage of a skilled digital workforce.

Currently, the participation of companies in IoT is a matter of decision-making, as the use and development of new, unfamiliar technologies is a risky and costly activity. Despite this, IoT holds significant potential for savings, which increases the revenue of those who make smart decisions.

3.4 Field Study Results:

After analyzing the characteristics of the sample, we will use arithmetic means and standard deviations to identify the general trend of the participants' opinions.

It is evident that there is agreement on the majority of the dimensions, indicating that the Internet of Things (IoT) has an impact on competitive advantage within the value chain. This is reflected in the key statements from the questionnaire and the analysis of these variables. The most important statement in the responses is Statement No. 1: "Accuracy in tracking and monitoring individuals and items within the value chain through automatically adjusted data", with a mean of 3.757 and a standard deviation of 0.867. This depends on the quality and quantity of the data and information available through the use of sensor technology on assets, which enables the company to track the product and its exact location. In fact, real-time alerts can also be provided for items that might be damaged during transportation, allowing companies to discover previously unknown deficiencies. This puts them in a better position to gain deep insights into manufacturing standards and quality practices.

Next is Statement No. 6: "Provision of large and diverse amounts of data for data analytics to make tactical and strategic decisions", with a mean of 4.018 and a standard deviation of 0.744. Modern IoT technologies applied to data enable companies to make smart decisions quickly and efficiently, allowing them to respond rapidly to changes in customer buying patterns. This can be done by automatically recalculating sales forecasts and planning manufacturing, purchasing, storage, and transportation operations to accommodate updated forecasts. Thus, these companies can clearly outperform slower competitors in adapting to the ever-changing market landscape.

Additionally, Statement No. 15: "Improvement of real-time search for inventory levels", with a mean of 3.756 and a standard deviation of 0.857, shows that IoT allows companies to monitor inventory with unparalleled accuracy. This results in more effective inventory management than what individuals could handle on their own. Companies can now check inventory levels at any time and receive alerts when stock levels are low, including future manufacturing stock. Moreover, all the data obtained in this way can be used to make manufacturing schedules more efficient. A modern example of IoT in inventory management is Amazon, which uses Wi-Fi-supported robots to scan QR codes on products for tracking and sorting.

Regarding Statement No. 20: "Accurate planning and adoption of the purchasing process in collaboration with our suppliers", with a mean of 4.156 and a standard deviation of 0.965, data derived from IoT technologies can be analyzed and used to make adjustments in purchase schedules. This enables companies to recognize and build relationships with suppliers. In such a scenario, it becomes crucial to pay attention to how suppliers handle the supplies they send to companies, which determines the quality of the inputs and the relationship with the supplier, thereby contributing to a good retention rate with competitors.

Statement No. 31: "Improvement of marketing transparency for customers", with a mean of 0.367 and a standard deviation of 0.854, reveals that in the past, consumers did not expect to know the complete history of a product, from the raw material source to the final delivery. However, with increased awareness and knowledge, consumers now have complete insight into the product journey. This shift is due to companies leveraging IoT technologies, which allow them to display ethical business practices and transparency, raising the transparency of the value chain to unprecedented levels and aligning the company's brand value with that of socially conscious customers.

Statement No. 32: "Accurate planning and adoption of exit, dispatch, and delivery processes through a better understanding of market trends", with a mean of 0.412 and a standard deviation of 0.975, highlights that delivery is the final and most sensitive stage, as it directly connects the product to consumers or ends the company's threshold. The delivery experience has a profound impact on the chances of repeat orders, so it is essential for companies to connect directly from the shipping container to delivery trucks for customers, or even to delivery trucks for retail distributors. This indicates that the study sample companies use data obtained from IoT systems to deliver products in a better, faster, and more efficient manner. IoT also helps them identify potential issues and make real-time changes to automatic delivery systems and truck methods, considering weather conditions.

Finally, Statement No. 38: "Improvement of predictive maintenance", with a mean of 3.591 and a standard deviation of 0.802, indicates that maintenance of machines and trucks is of utmost importance, as any failure in such machines, such as factory equipment or delivery trucks, could cause delays, thus reducing the efficiency of the value chain. By continuously using IoT, sensors installed in these machines provide information that can be collected and analyzed to determine the schedules for predictive maintenance activities. This allows for better planning of reactive preventive maintenance schedules compared to the traditional systems based on older devices. The data captured by IoT helps prevent increased costs due to equipment failure.

3.5 Hypothesis Testing

To test the hypotheses of the study, we use SmartPLS, which is a software tool for Structural Equation Modeling (SEM). It is used to test linear and additive causal models theoretically using second-generation multivariate analysis tools. The unknown set can be modeled using Bootstrapping methods, and the significance level is tested using T-statistics and P-values. Seven hypotheses were tested in our research, and the path coefficients and statistical results are summarized in the following table.

Table 3. Results of Hypothesis Testing

Path	Std. Beta	Std Error	T-value	P-value	R	R2
Internet of Things → Integration of Competitive Advantage in the Value Chain	0.663	0.018	2.354	0.000	0.992	0.782
Internet of Things → Integration of Internal Processes	0.221	0.092	3.416	0.000	0.745	0.721
Internet of Things → Supplier Integration	0.365	0.078	1.994	0.000	0.845	0.716
Internet of Things → Customer Integration	0.243	0.068	2.596	0.000	0.836	0.694
Internal Process Integration → Competitive Advantage in the Value Chain	0.121	0.031	1.973	0.000	0.980	0.717
Supplier Integration → Competitive Advantage in the Value Chain	0.242	0.013	3.555	0.000	0.905	0.745
Customer Integration → Competitive Advantage in the Value Chain	0.516	0.010	2.413	0.000	0.849	0.821

Source: Prepared by the researcher based on the outputs of Smart PLS.

From the table above, we observe that all T-statistic values exceed 1.96 and the P-values are less than 0.05 at a significance level of 0.01 for each non-standardized coefficient contribution of the latent variables. This indicates the presence of statistically significant causal relationships according to path analysis, which enables hypothesis testing (both main and sub-hypotheses) between variables. The results showed the following:

- The main hypothesis regarding the statistically significant effect of the Internet of Things on the integration of competitive advantage in the value chain at a significance level of 0.01: This hypothesis tests the effect of the Internet of Things on the integration of competitive advantage in the value chain. The effect of the Internet of Things is found to be high, as the T-value (2.354) indicates a high level of confidence of over 99%. Therefore, the hypothesis is accepted: ($\beta = 0.663$, $P < 0.01$).

- Sub-hypothesis 1: There is a statistically significant effect of the Internet of Things on the integration of internal processes at a significance level of 0.01. This hypothesis tests the effect of the Internet of Things on the integration of internal processes. The effect of the Internet of Things is considered high, as the T-value (3.416) indicates a high level of confidence of over 99%. Therefore, the hypothesis is accepted: ($\beta = 0.221$, $P < 0.01$).
- Sub-hypothesis 2: There is a statistically significant effect of the Internet of Things on supplier integration at a significance level of 0.01. This hypothesis tests the effect of the Internet of Things on supplier integration. The effect of the Internet of Things is considered high, as the T-value (1.994) indicates a high level of confidence of over 99%. Therefore, the hypothesis is accepted: ($\beta = 0.365$, $P < 0.01$).
- Sub-hypothesis 3: There is a statistically significant effect of the Internet of Things on customer integration at a significance level of 0.01. This hypothesis tests the effect of the Internet of Things on customer integration. The effect of the Internet of Things is considered high, as the T-value* (2.596) indicates a high level of confidence of over 99%. Therefore, the hypothesis is accepted: ($\beta = 0.243$, $P < 0.01$).
- Sub-hypothesis 4: There is a statistically significant effect of internal process integration on competitive advantage in the value chain at a significance level of 0.01. This hypothesis tests the effect of internal process integration on competitive advantage in the value chain. The effect of internal process integration is considered high, as the T-value (1.973) indicates a high level of confidence of over 99%. Therefore, the hypothesis is accepted: ($\beta = 0.121$, $P < 0.01$).
- Sub-hypothesis 5: There is a statistically significant effect of supplier integration on competitive advantage in the value chain at a significance level of 0.01. This hypothesis tests the effect of supplier integration on competitive advantage in the value chain. The effect of supplier integration is considered high, as the T-value (3.555) indicates a high level of confidence of over 99%. Therefore, the hypothesis is accepted: ($\beta = 0.242$, $P < 0.01$).
- Sub-hypothesis 6: There is a statistically significant effect of customer integration on competitive advantage in the value chain at a significance level of 0.01. This hypothesis tests the effect of customer integration on competitive advantage in the value chain. The effect of customer integration is considered high, as the T-value (2.413) indicates a high level of confidence of over 99%. Therefore, the hypothesis is accepted: ($\beta = 0.516$, $P < 0.01$).

The results confirm the hypothesized relationships between the constructs in the applied framework, indicating that integration with (internal processes/suppliers/customers) enabled by the Internet of Things has a positive and significant effect on competitive advantage in the value chain. This, in turn, positively impacts the companies under study, confirming the acceptance of the hypotheses.

Conclusions.

The one thing that can be said without a shadow of a doubt is that the Internet of Things (IoT) will create better interactive solutions with the advancement of technology. IoT will bring about significant changes in the way the value chain operates, as well as drive the manufacturing and supply chain towards a digital transformation path. It will continue to transform value chain processes as the benefits of integrating IoT into current operations become increasingly clear. More companies and organizations will expand the capabilities of the value chain to be more efficient, effective, productive, and sustainable in the future, ultimately reaching the concept of the digital value chain in the digital economy.

The Internet of Things is considered one of the most promising technologies for controlling competitive advantage integration in the value chain, which contributes to the success of any industrial company. Therefore, IoT is gaining significant attention from a wide range of companies to improve performance and reputation, thus acquiring more customers and increasing profits.

Challenges will emerge as the product value chain evolves towards the future, and differentiation between products will be crucial for manufacturers. They will need cost-effective development capabilities to keep up with the rapid transformation. If value chains are managed correctly, in applying and integrating IoT technologies, companies will become more resilient and quickly adapt to the rapidly changing industrial landscape.

Companies that invest in IoT technologies and tools today are the ones that will succeed in the next decade. IoT solutions enable companies to deliver new, innovative services faster and with less risk to their customers, providing a real, lasting competitive advantage. IoT allows value chains to better manage their operations from production to delivery, providing real-time data connected to machines, vehicles, inventory, and digital automation. Data analytics help identify trends and opportunities. If problems arise, companies can spot and resolve them before they impact partners or customers.

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