

## **The Role of Manufacturing Information Systems (MIS) in Enhancing Productivity in Algeria**

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### **Abstract:**

The world is currently experiencing a profound transformation in technology usage, commonly referred to as “Industry 4.0” or “Digital Transformation”. This technological paradigm shift serves as a cornerstone for economic progress. In this context, Manufacturing Information Systems (MIS) emerge as a crucial tool that aids businesses in making informed decisions. This paper’s objective is explaining the concept of MIS and drawing its importance in managing the production. Thus, it seeks to highlight the crucial role of information in manufacturing systems and reveal the necessity of considering the Information Systems (IS) along with production management. Therefore, the key concepts (management information system, manufacturing information system, smart manufacturing system, and total manufacturing information system) are defined. Then, the importance of information for MIS, and the MIS evolution and its structure are included. Next, we conducted a literature review of research on MIS in Algeria. Finally, we assessed the use of MIS in Algerian companies, and then we explained the role of MIS in enhancing productivity in Algeria.

**Keywords:** Manufacturing information system, MIS, Management information system, Information system, Smart manufacturing, Manufacturing system, Industrial practice.

**JEL Classification:** C88 ; C87 ; L8 ; L86 ; L69 ; O14

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### **Introduction**

In contemporary organizations, Information Technology (IT) holds is pivotal in facilitating the seamless execution of daily operations. The current landscape, marked by heightened competition, globalization, technological progress, a growing emphasis on customer contentment and values, and mounting economic pressures, has significantly elevated organizations' reliance on IT. Technological advancement, coupled with the integration of automation tools, has notably streamlined and enhanced the efficiency of data processing and problem-solving tasks (Talha Awan & Aqeel, 2019). The world is currently experiencing a profound transformation in technology usage, commonly referred to as Digital Transformation, Industry 4.0, or the 4<sup>th</sup> Industrial Revolution. This technological paradigm shift, driven by the adoption of Industry 4.0 technologies, serves as a cornerstone for economic progress. It fuels the innovation process, relying on the accumulation and strategic utilization of pertinent knowledge. These technologies transcend the confines of individual organizations, promoting greater openness to collaboration with external stakeholders and fostering innovation within the framework of a national innovation system (Dehimat & Baroudi, 2022).

Likewise, Information Systems (IS) have emerged as a pivotal element in the contemporary landscape, significantly influencing an organization's performance. IS comprises multiple interconnected components designed to collect, process, store, analyze, and disseminate critical information. This information is instrumental in an organization's ability to exercise control, conduct day-to-day transactions, support managerial decision-making processes, and generate informative reports (Talha Awan & Aqeel, 2019). An escalating number of organizations are strategically employing Information Systems (IS) to gain a substantial edge in their operations. There is a growing emphasis on effectively managing the synergy between strategy and technology to forge new avenues for attaining a competitive advantage. These firms amalgamate their manufacturing functions and overall business strategy within the framework of an IS. By skillfully extending this integrated system approach beyond the conventional scope of manufacturing functions, these firms strike a harmonious equilibrium between manufacturing adaptability and product standardization. IT is a pivotal component in this emerging strategy, offering a key ingredient for achieving competitive superiority in manufacturing (Y. Lee, 2006).

Industrial software stands as the linchpin of contemporary manufacturing, facilitating the seamless interaction between industrial technology and Information Technology (IT) across various tiers. A prevailing consensus underscores the notion that cutting-edge industrial software necessitates an ongoing accumulation of domain-specific industrial knowledge within the manufacturing domain (YU, LI, LIU, CHEN, & WEI, 2021).

In today's business landscape, there has been a profound transformation in how products and services are delivered to customers compared to the past. Presently, the realms of production are predominantly characterized by the prevalence of computers, robotics, and information systems. Across the globe, businesses are increasingly recognizing that effective knowledge management hinges upon Information Systems (IS). This recognition is primarily attributed to the fact that numerous critical decisions, such as production volume and timing for specific products, are now computer-driven. In this context, Manufacturing Information Systems (MIS) emerge as a crucial tool that aids businesses in making informed decisions (Sari, 2020).

The information technology revolution is rapidly bridging the gap between people, processes, and equipment that were once separated by physical barriers. This transformation is especially significant in the industrial sector. The proliferation of advanced communication methods, unprecedented data storage capacity, and emerging technologies like cloud computing and artificial intelligence have opened up new possibilities for the traditional manufacturing industry. These advancements enable the integration of a multiple industrial software, connecting machinery, systems, and human operators to create smart, responsive, and sustainable manufacturing enterprises. In accordance with their various applications, industrial software can be categorized into diverse types, as illustrated in **Figure 1**:

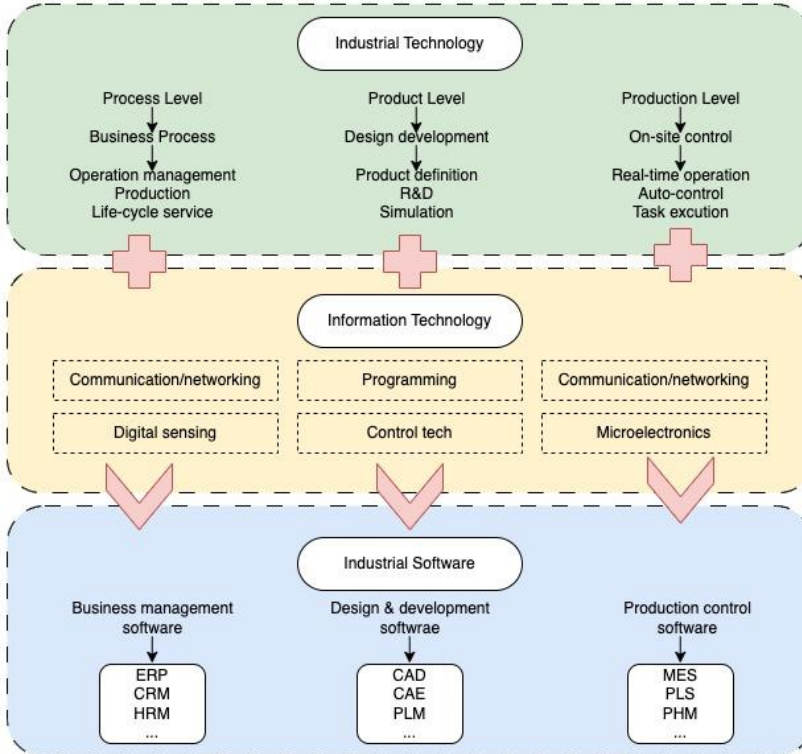
1. *Design and Simulation Software*: Examples here encompass Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Computer-Aided Engineering (CAE), and Product Lifecycle Management (PLM).
2. *Business Management Software*: This category includes tools like Human Resource Management (HRM), Enterprise Resource Planning (ERP), and Customer Relationship Management (CRM) among others.
3. *Production Control Software*: This category encompasses Manufacturing Execution Systems (MES), Maintenance, Repair &

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Operations (MRO), Process Control Systems (PCS), and Prognostics Health Management (PHM), among others.

This classification technique is widely accepted and has also been incorporated into Siemens' Industry 4.0 framework (YU, LI, LIU, CHEN, & WEI, 2021).

**Figure number (1): Industrial software and information integration**



**Source: Adopted from (YU, LI, LIU, CHEN, & WEI, 2021)**

Simultaneously, there exist several hurdles that organizations need to navigate when implementing Manufacturing Information Systems (MIS). These challenges include:

- *Resource Constraints:* Insufficient resources, both in terms of finances and technology, can impede successful MIS implementation.
- *Employee Engagement:* Motivating employees and securing their active participation is crucial for MIS effectiveness.
- *Leadership Buy-In:* The commitment of top management and staff involvement is vital for the success of MIS initiatives.

- *Organizational Dedication*: the adoption of an MIS and its integration into daily operations, can be prevented due to low organizational commitment.
- *Training Shortages*: A lack of adequate training programs can leave employees ill-equipped to utilize MIS effectively.
- *Resistance to Change*: Counterproductive attitudes and resistance to change among employees can pose significant challenges.
- *Integration Challenges*: The absence of clear integration guidelines and management commitment can hinder the seamless implementation of MIS.
- *Cultural Shifts*: Implementing MIS demands a cultural change within the organization, which can be met with resistance.
- *Expertise Shortage*: A shortage of skilled auditors and consultants who understand MIS can complicate the implementation process.
- *Inadequate Audit Practices*: Misguided or incomplete audit approaches can hinder the assessment and optimization of MIS.
- *Resource Deficiency*: A shortage of human and other resources can limit the effectiveness of MIS.
- *Interdepartmental Collaboration*: Insufficient support and a lack of collaboration between different departments can obstruct the smooth implementation and effective utilization of MIS (Benyettou & Abdellatif, 2018).

The present work aims to investigate and recognize the status of Manufacturing Information Systems (MIS) in Algerian companies. This paper's objective is explaining the concept of MIS and drawing its importance in managing the production. Thus, it seeks to highlight the crucial role of information in manufacturing systems and reveal the necessity of considering the Information Systems (IS) along with production management. In this article's organization, first, the key concepts (management information system, manufacturing information system, smart manufacturing system, and total manufacturing information system) are defined. Then, the importance of information for MIS, the evolution and structure of MIS are included. Next, we conducted a literature review of research that studied MIS in Algeria. Finally, we assessed the use of MIS in Algerian companies, and then we explained the role of MIS in enhancing productivity in Algeria.

## **1- Key concepts**

### **1-1- Concept of Management Information System**

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A Management Information System or Information Management System represents a comprehensive software-based solution for business management that leverages data acquisition, computer networking, transmission technology, database construction, multimedia technology, and business requirements. Its primary objective is to facilitate data and information sharing across various business systems and subsequently establish a foundation for queries and adjustments. Ultimately, it contributes to the development of a decision-support system, aiding in informed decision-making (Tang & Liu, 2020).

An Information Management System serves as an information system designed for various crucial functions within an organization, notably decision-making, coordination, control, analysis, and information visualization. This system is particularly essential within a company or organizational context. The field of management information systems, or management, entails the study of the interplay between individuals and technology within an organizational framework. In the realm of business, the primary objective of implementing a management information system is to enhance the overall value and advantages derived by the organization. It strives to optimize business processes and outcomes (BOURI, 2019).

Information systems are composed of interconnected subsystems, each housing its own distinct set of information. Effective information management is essential to oversee and integrate this diverse array of data. As companies conduct their operations, they rely on a multitude of information sources, both internal and external, to guide their activities (Sari, 2020).

### **1-2- Concept of Manufacturing Information System (MIS)**

The Manufacturing Information System is one of the information systems that is purposed for data acquiring. The data is concerning the production stations work and their flow (Sari, 2020). The primary objective of the Manufacturing Information System (MIS) is to gather information regarding the physical movement of products within the organization. This encompasses critical aspects like quality control, production planning and control, and inventory management. MIS primarily deals with internal data and historical records. It encompasses all the necessary processes to create products or provide services.

For fulfilling its functions effectively, the system identifies the production area, designs the layout, and establishes a production plan. Additionally, the MIS is responsible for procuring the required raw

materials, parts, and sub-assemblies for producing the specified product or service within the production area. It also allocates the necessary workforce to meet production demands and schedules resources optimally to ensure timely product delivery for fulfilling orders. Moreover, during the production process, the system monitors resource utilization and associated costs. All these operations are managed within a virtual environment by the manufacturing information system (MIS) (Sarı, 2020).

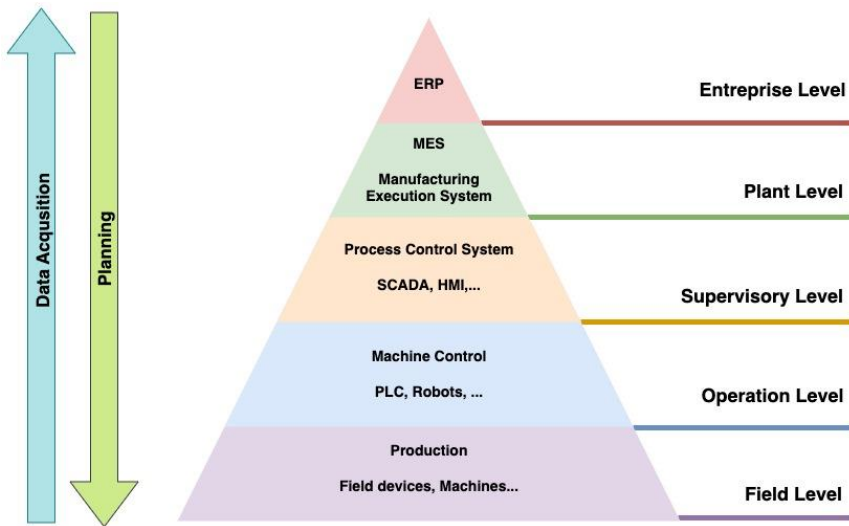
### **1-3- Smart Manufacturing Information System (SMIS)**

Smart manufacturing, often referred to as network-based data and information integration, plays a pivotal role in enabling real-time information exchange within production and supply chains. It establishes logical cause-and-effect relationships and it is a valuable management and planning tool. Smart manufacturing simplifies the analysis, modelling, and real-time simulation of data gathered from sensors. This data remains consistently available and presented in the most suitable format throughout the entire design, engineering, planning, and production cycle. Over the years, the evolution of MIS has been marked by the processing of data collected from production sites, as well as their interaction with IS within other operational subsystems. Presently, production systems have evolved into smart systems with the integration of ITs. Smart Manufacturing Information Systems (SMIS) are at the forefront of this transformation. They serve as production tracking and management systems that enable real-time monitoring of production machinery and plans. The data (collected from machines, products, and product components through sensors) is continuously inputted into these SMIS (See **Figure 2**) (Sarı, 2020).

**Figure number (2): Information flow hierarchy in Smart Manufacturing Systems.**

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**Source: Adopted from (Sari, 2020)**

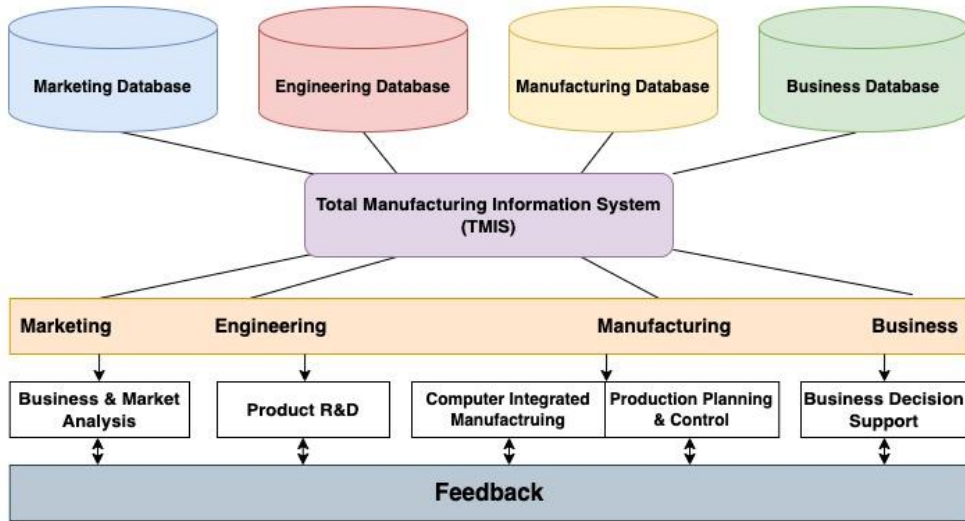
### **1-4- Total Manufacturing Information System (TMIS)**

A total MIS represents a specialized MIS that aspires to seamlessly merge distinct manufacturing, engineering, and business functions into a fully integrated IS. **Figure 3** illustrates the integration of advanced manufacturing technologies with other crucial applications, leading to a novel approach to creating the ultimate total manufacturing information system.

TMIS offers several critical components, including a shared database with management capabilities besides a communication network. These elements connect various functions within the organization, such as design and engineering, product development, procurement, quality control, manufacturing, and marketing. This integration unlocks heightened business capabilities that surpass what individual systems can achieve in isolation (Lee, 2003).

**Figure number (3): Total Manufacturing Information System (TMIS) approach.**





Source: Adopted from (Lee, 2003)

## 2- The importance of information for manufacturing systems

Enterprises harness all available business information to advance their competitiveness and achieve their objectives. Consequently, the management of information holds paramount importance for companies. Business decisions, spanning various timeframes such as daily, weekly, monthly, and annually, are formulated based on this vital information.

The necessity for Manufacturing Information Systems (MIS) is on the rise, driven by the recognition that production extends beyond mere factory-based manufacturing processes. It encompasses a broader spectrum of activities involving the conversion of energy, information, and materials across all enterprises engaged in the production of goods and services. In this context, materials, components, documents, or customer data serve as inputs, undergoing a series of transformative processes. These processes may vary widely, encompassing mechanical operations, chemical analysis, assembly, monitoring, inspection, reception, dispatch, and documentation.

The yield of this system encompasses finished parts, chemical compositions, products, completed processes, and finalized documents, along with an integral information component. Additionally, it features a decision-making and control subsystem. The production system places significant emphasis on the core elements of production information systems, which facilitate control and decision-making processes through the seamless flow of information (Sari, 2020).

## 3- The evolution of MIS

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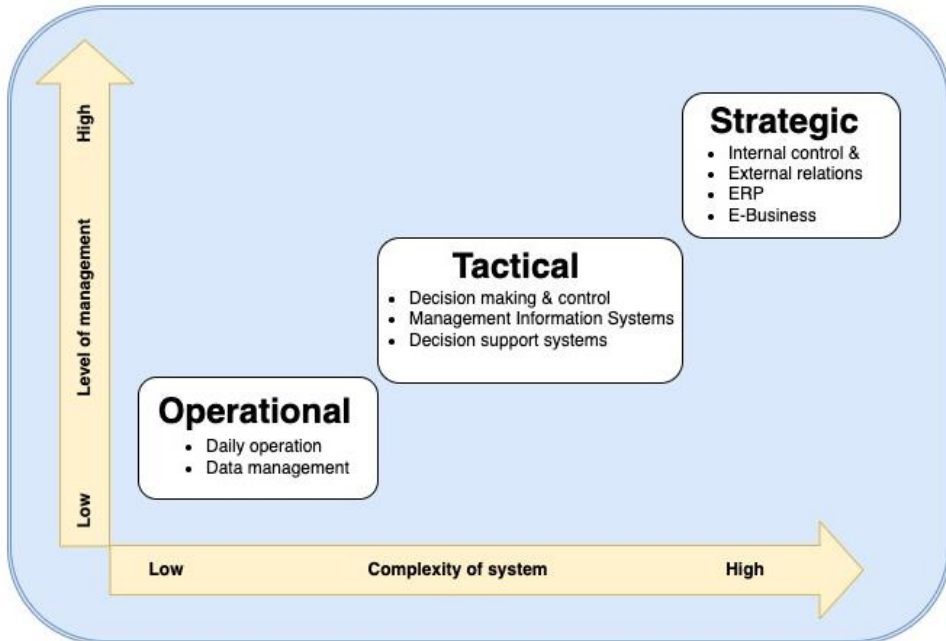
The emergence and growth of the system approach in production management largely align with the post-Second World War period. During this era, the advancement of sophisticated information processing and mathematical techniques tools, which enabled the resolution of intricate and all-encompassing problems, played a pivotal role in shaping the system approach in production management. Following this phase, there is a noticeable trend toward the increased utilization of information systems in both the design and execution of operational systems. This evolution underscores the pivotal role of technology and systematic methodologies in modern production management (Sari, 2020).

In the early days of integrating Information Technology (IT) into business management, the focus primarily revolved around inventory control and manufacturing processes, exemplified by systems like Material Requirement Planning (MRP) and Manufacturing Resource Planning (MRPII). However, as we entered the 1990s, software vendors expanded the scope of these systems to encompass various other functions within an enterprise, including engineering, finance, human resources, sales, and distribution. This broadened integration aimed to cover the entire spectrum of activities within an organization. While IT skills became increasingly vital for these companies, many of them lacked expertise in the IT domain. As a result, organizations began to prioritize internal development and maintenance efforts for core functions that added value and boosted their competitive advantage. Conversely, they outsourced non-core functions.

Consequently, numerous companies, particularly in the manufacturing sector, began outsourcing their IS projects for maintenance and development. Concurrently, the rapid growth of the Internet facilitated significant advancements in Information and Communications Technology (ICT) tools. Many information-focused firms transitioned into Information Service Providers (ISPs), offering top-notch IS outsourcing services. For example, numerous ERP vendors shifted their focus to providing rental ERP products and transformed their offerings into information services. The proliferation of ISPs marked a significant trend in the IT industry, providing valuable resources for outsourcing (Wei, Cheng, & Lee, 2019).

**Figure 4** illustrates the progression of information technologies. This evolution aligns with the generation of information that can be harnessed at various management levels, adapting to the complexity of production management across different stages (Sari, 2020).

**Figure number (4): Evolution of information technologies.**



**Source: Adopted from (Sarı, 2020)**

#### **4- The structure of MIS**

An MIS is an encompassing, integrated system that incorporates all the functional activities, tasks, and processes necessary for products manufacturing (See **Figure 5**). It represents a suite of computer-based, interconnected applications designed to offer manufacturing companies a unified framework and a singular access and control mechanism for all forms of information, including software and hardware components. This system comprises seven essential subsystems:

- 1) Business Decision Support;
- 2) Product R&D;
- 3) Computer Integrated Manufacturing (CIM);
- 4) Production Planning and Control (PPC);
- 5) Quality Control (QC);
- 6) Business and Market Analysis;
- 7) Feedback.

Each of these subsystems requires ongoing enhancement, both individually and as part of the integrated system. This continual improvement process aims to decrease product development cycle times and boost the overall operational efficiency (Y. Lee, 2006).

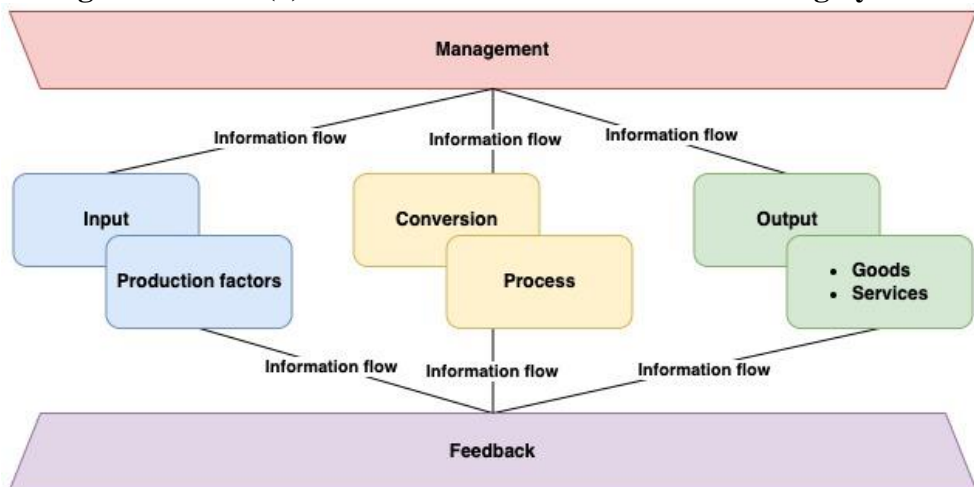
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An MIS envelops a range of operational functions that are integral to its efficient functioning. Which can be categorized into several key areas as follow:

- **Operation Process Functions:** These functions include warehouse management, order tracking, technology utilization, and the dissemination of warehouse-related information.
- **Production, Control, and Reporting Functions:** These functions include cost control, production control, and input control, among others.
- **Non-Structural Production Planning Functions:** This set includes input supply management, production planning, transportation planning, maintenance planning, and storage management.
- **Structural Production Planning Functions:** These functions are more strategic and focus on the structural aspects of production. They include activities such as location selection for production facilities, technology selection, capacity determination, the allocation of structural production resources, and long-term demand forecasting (Sari, 2020).

**Figure number (5): Information flow in a Manufacturing System**



Source: Adpted from (Sari, 2020)

### 5- The MIS Levels

An MIS supports production management functions and production systems at different management levels, including operational, tactical, and strategic aspects within the enterprise. Manufacturing Information Systems (MIS) are then examined concerning these three decision structures in the organization (Sari, 2020).

- **Operational MIS**

Manufacturing information systems, at the operational level, furnish the essential information necessary for overseeing production tasks and functions like procurement, inventory management, quality control, and computer-aided design and manufacturing (Sari, 2020).

- **Tactical MIS**

At the tactical level, MISs encompass subsystems that gather and report the information needed for the supervision and governance of production resources. This category includes systems like MRP, MRPII, just-in-time production (JIT) systems, and production scheduling systems. These systems provide support for semi-structured production decisions at the tactical level (Sari, 2020).

- **Strategic MIS**

Systems, at the strategic level are harnessed to aid senior management in making production decisions that entail substantial capital investment and long-term planning (Sari, 2020).

## **6- Literature Review**

### *Manufacturing and management information system studies in Algeria*

In the study by Benyettou and Abdellatif (2018), they conducted empirical research to assess the current level of integrated management systems (IMS) in Algerian companies and evaluate their performance. To accomplish this objective, they employed a structured questionnaire survey distributed to 250 selected enterprises. Only 115 of these companies responded, with 65 having already implemented an IMS. These enterprises varied in size and industry, operating across Algeria. The study utilized confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) techniques to analyze the data. Additionally, correlation and stepwise regression analyses were conducted to uncover relationships between theoretical constructs. The findings shed light on the level of IMS in Algerian companies, offering specific recommendations to enhance the understanding of integration processes within Algerian companies. However, it's worth noting that the study's major limitation is its relatively small sample size, limiting the generalizability of its findings. Nonetheless,

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this research serves as a valuable starting point for further investigations, especially in developing countries (Benyettou & Abdellatif, 2018).

Dahinine, Chouayb, and Bensahel (2023) explored the impact of Knowledge Management (KM) on the performance of SMEs in the Food and Beverag industry in Algeria. They conducted a questionnaire involving 210 managers of Algerian SMEs. The study particularly highlighted the moderating role of trust in facilitating the acquisition, sharing, and application of knowledge within companies to enhance both financial and non-financial performance. The researchers utilized PLS-SEM with SmartPLS 3.2.7 statistical software to analyze these effects. The results demonstrated a positive and significant influence of knowledge management on SMEs' performance. Furthermore, they revealed that the direct impact of Knowledge Management on firm performance was substantially strengthened in the presence of a high level of trust (Dahinine, Chouayb, & Bensahel, 2023).

In Boudia's (2020) analysis, the focus was on examining the relationships between Information Systems (IS) and Business Intelligence (BI). The study emphasized the importance of collecting and managing information, making it accessible to users who require it. Business intelligence was recognized as a valuable approach for gathering and processing information, beginning with problem identification, defining necessary indicators, and concluding with problem resolution. IS, with their technical capabilities and extensive reach, were found to significantly expedite BI development and contribute to a collective culture of information (Boudia, 2020).

Boudiaf and Belhadj (2019) focused on measuring the correlation between human resources information system and IT, considering various aspects. Their research encompassed a sample of 32 agencies in the Algerian east region. Data collection and analysis were carried out using statistical tools such as Cronbach's Alpha, descriptive statistics (e.g., Std. Deviation, Std. Error Mean, Mean, etc.), and One-Sample Kolmogorov-Smirnov Test, as well as correlation coefficients to test hypotheses with SPSS V20. The primary finding of this investigation revealed a strong positive correlation between dimensions of information technology and the enhancement of HR information system performance (Boudiaf & Belhadj, 2019).

Gaid and Helaili's (2020) research aimed to identify the contribution ERP systems to the activation of the accounting information system in economic institutions. They delved into the nature of ERP systems,

elucidating their benefits and the requirements for successful implementation. The study emphasized the significance of ERP systems in information technology, particularly in ensuring that the accounting information system receives integrated, timely, and relevant data, enhancing information completeness. (Gaid & Helaili, 2020).

## **7- The Role of MIS in enhancing productivity in Algeria**

In the ever-evolving global business environment, particularly within Algeria's customer-centric markets characterized by short product life cycles, manufacturing information systems perform a central role in boosting productivity for Algerian manufacturing companies. These systems effectively collaborate with diverse functional units within these organizations, granting them a competitive edge. The essential contributions of MIS in enhancing productivity can be outlined as follows:

- 1) ***Integration of Information Technology***: MIS underscores the critical importance of advanced information technology applications in achieving success. It recognizes that contemporary production processes in Algeria are increasingly characterized by intellectual endeavours rather than physical labour, emphasizing the inherent interconnection between advanced production technology and information technology.
- 2) ***Foundation of Efficient Operations***: When considered alongside information technologies, manufacturing systems establish the cornerstone for efficient operations within Algerian manufacturing companies. MIS functions as an integrated information system encompassing all facets related to the planning and oversight of production processes, both for goods and services. This integration forms the fundamental basis for streamlining operations.
- 3) ***Automation and Enhanced Applications***: The automation of manufacturing systems through information technology has led to the development of diverse applications, including MRP, inventory management, resource planning, and product development and design. These applications expedite Algerian decision-makers' access to accurate and reliable information within shorter timeframes.
- 4) ***Managerial Support***: The primary objective of establishing a manufacturing information system within Algerian manufacturing companies is to assist managers in strategic planning, resource organization, activity management, and outcome control. Additionally, MIS enables production managers to obtain a deeper

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understanding of the intricate interconnections inherent in the Algerian manufacturing process.

- 5) ***Facilitating Access to Precise Information:*** A well-founded manufacturing information system within Algerian companies ensures that managers can access information that is accurate, comprehensive, timely, and concise. Effective utilization of this information significantly contributes to enhancing the decision-making processes of managers.
- 6) ***Strategic Empowerment:*** MIS empowers manufacturing firms to construct a strategic instrument that operates at all stages of manufacturing operations, ranging from the formulation of business strategies, data collection, or data analysis for new products, all through a fully integrated information system. This comprehensive approach equips companies to efficiently manufacture various products, respond promptly to market fluctuations, reduce time-to-market, adapt to shorter life cycles of products, and cultivate high-quality personalized designs.
- 7) ***Competitive Edge:*** By enabling time-based competition across markets or products, MIS provides Algerian firms with a substantial competitive advantage. It equips them to thrive in an evolving business environment, bolstering their ability to meet market demands within Algeria and beyond.
- 8) ***Management of Complex Manufacturing Environments:*** As firms enhance their MIS capabilities, they become better equipped to oversee increasingly intricate manufacturing environments. The decision support capabilities inherent in MIS facilitate effective management within the dynamic context.

### **Conclusion**

In essence, Manufacturing Information Systems serve as a driving force behind productivity enhancements and foster strategic thinking within manufacturing companies, ultimately strengthening their competitiveness in the marketplace both domestically and internationally. Algerian companies, like other organizations worldwide, are seeking new and fresh approaches for enhancing their competitiveness to encounter the environment changes. Today, the implementation and accomplishment of numerous standards is massive, as the performance of the companies depends on it. Nevertheless, these companies have difficulty to manage multiple standards with distinct



procedures, processes, and documentation. Hence, adopting the MIS is the primary solution to tackle and face this challenge.

Manufacturing information systems hold a significant role within management frameworks. Irrespective of whether it's applied in large production facilities or medium-sized enterprises, these systems render production data traceable, placing production information at the core of business operations. This role becomes increasingly critical in decision-making scenarios where management relies on data and information. Nonetheless, the effectiveness, efficiency, and traceability of this system hinge on its application. MIS system, which lay the groundwork for decision-making across strategic, tactical, and operational dimensions, function as a form of advisory hub for businesses, contingent upon the extent of their deployment. The advancement of MISs will persist in alignment with the progress in ITs. These enhancements will foster the refinement of forecasting and management capabilities within businesses, enabling the formulation of optimal decisions.

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