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The Role of the ERP System in Driving Digital Transformation: Digital Maturity as a Mediating Variable (A Field Study at Sonatrach – Hassi R'Mel)

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بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

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Dedication

I dedicate this work to my dear **father** and **mother**, my pillars of strength and support. To my **sister**, **brothers**, and **extended family**, for their endless encouragement and prayers throughout this journey. To my beloved **Soujoud** & **Racim**.

To everyone I love, and to all who love me.

To all my dear **friends**, thank you for being part of my success.

Sana Bakhouche

ABSTRACT

This study explores the impact of Enterprise Resource Planning (ERP) systems on Digital Transformation at Sonatrach (Hassi Rmel), with Digital Maturity as a mediating variable. The research adopts a descriptive-analytical approach to examine the relationship between the variables. Data were collected from a sample of 69 employees via a questionnaire and analyzed using IBM SPSS Statistics (v31.0) and SmartPLS 4 (SEM).

The findings confirm that the ERP system significantly drives digital transformation. Moreover, results reveal that Digital Maturity acts as a partial mediator in this relationship, indicating that while ERP directly influences transformation, its effectiveness is further enhanced through higher maturity levels. However, the study identified a "maturity gap" due to persistent manual tasks. These results suggest that Sonatrach should prioritize digital culture and human skills to fully leverage ERP capabilities.

Keywords: SAP, ERP, Digital Maturity, Digital Transformation

ملخص الدراسة

تستكشف هذه الدراسة أثر أنظمة تخطيط موارد المؤسسة (ERP) على التحول الرقمي في شركة سوناطراك (حاسي الرمل)، مع اعتبار النضج الرقمي كمتغير وسيط. تتبنى الدراسة المنهج الوصفي والتحليلي لفحص العلاقة بين المتغيرات. تم جمع البيانات من عينة مكونة من 69 موظفاً عبر استبيان، وحُللت باستخدام برنامج IBM SPSS Statistics (v31.0) وبرنامج SmartPLS 4 (SEM).

تؤكد النتائج أن نظام SAP يدفع التحول الرقمي بشكل كبير. علاوة على ذلك، تكشف النتائج أن النضج الرقمي يعمل كوسيط جزئي في هذه العلاقة، مما يشير إلى أنه بينما يؤثر SAP بشكل مباشر على التحول، فإن فاعليته تزداد من خلال مستويات النضج الرقمي العالية. ومع ذلك، حددت الدراسة وجود "فجوة نضج" بسبب المهام اليدوية المستمرة. تقترح هذه النتائج وجوب إعطاء سوناطراك الأولوية للثقافة الرقمية والمهارات البشرية للاستفادة الكاملة من إمكانيات نظام ERP.

الكلمات المفتاحية: نظامSAP ، نظامERP ، النضج الرقمي، التحول الرقمي.

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LIST OF ABBREVIATIONS

- **ERP** : Enterprise Resource Planning
- **SAP** : Systems, Applications, and Products in Data Processing
- **SEM- PLS**: Structural Equation Modeling – Partial Least Squares
- **DM** : Digital Maturity
- **DT** : Digital Transformation
- **SPSS**: Statistical Package for the Social Sciencesspss-
- **R^2** : Coefficient of Determination
- **Q^2** : Predictive Relevance
- **f^2**: Effect Size
- **CR** : Composite Reliability
- **AVE** : Average Variance Extracted
- **HTMT** : Heterotrait–Monotrait Ratio
- **VIF** : Variance Inflation Factor
- **SONATRACH** : Algerian national oil and gas company (acronym of the French "Société Nationale pour la Recherche, la Production, le Transport, la Transformation et la Commercialisation des Hydrocarbures").
- **HRM** : Hassi R'Mel Directorate

General Framework of the study

GENERAL FRAMEWORK OF THE STUDY

A. Background

In the context of rapid digital transformation, organizations can no longer rely on traditional management practices and fragmented information systems to remain competitive. In an environment characterized by continuous technological disruption, increasing customer expectations, and global competition, firms are compelled to rethink how they design their processes, manage their resources, and innovate in their business models to achieve sustainable strategic and operational success.

Within this shifting landscape, Enterprise Resource Planning (ERP) systems have emerged as a core strategic infrastructure that integrates previously isolated functions such as finance, human resources, production, supply chain, and customer relations into a unified platform that supports real-time information flows and data-driven decision-making. By centralizing and standardizing organizational data, ERP systems help eliminate information silos, ensure data consistency, and provide a single source of truth that underpins more accurate, timely, and coordinated managerial decisions. This integrated architecture enables organizations to streamline business processes, reduce redundancies and operational waste, and enhance their responsiveness to internal and external changes, thereby improving both efficiency and agility.

Moreover, the role of ERP systems in digital transformation extends beyond back-office integration. Modern ERP solutions increasingly incorporate advanced analytics, automation, and cloud-based capabilities, allowing organizations to monitor key performance indicators in real time, simulate different scenarios, and anticipate market trends rather than merely react to them. In this sense, ERP systems function as a digital backbone that connects data, processes, and people, and thus constitute a critical enabler for organizations seeking to transition from traditional, functionally fragmented structures to digitally integrated, process-oriented models aligned with the demands of the digital economy.

However, the successful deployment of ERP systems goes beyond the mere adoption of a technological solution. Their real impact depends on the organization's level of digital maturity, which reflects its ability to embed digital technologies within its processes, structures, and culture in a way that fosters learning, innovation, and continuous improvement. In this sense, digital maturity acts as an enabling context that allows ERP systems to fully support digital transformation, not only by improving operational efficiency, but also by reshaping how the organization perceives, interprets, and uses information to sustain its competitive position in the digital economy.

B. Research problem and sub-questions

Given the above, the main research problem can be formulated as follows:

What is the effect of the Enterprise Resource Planning (ERP) system on driving digital transformation in the presence of digital maturity as a mediating variable?

This problem requires answering the following sub- questions:

1. Does the Enterprise Resource Planning (ERP) system have a positive and significant effect on digital transformation at Sonatrach – Hassi R'Mel?
2. Does the Enterprise Resource Planning (ERP) system have a positive and significant effect on digital maturity at Sonatrach – Hassi R'Mel?
3. Does digital maturity have a positive and significant effect on digital transformation at Sonatrach – Hassi R'Mel?
4. Does digital maturity play a mediating role in the relationship between the Enterprise Resource Planning (ERP) system and digital transformation at Sonatrach – Hassi R'Mel?

C. Research hypotheses

Based on the research problem and its sub- questions, the following hypotheses were formulated:

- **H1:** Enterprise Resource Planning (ERP) systems have a positive and significant effect on digital transformation.
- **H2:** Enterprise Resource Planning (ERP) systems have a positive and significant effect on digital maturity.
- **H3:** Digital maturity has a positive and significant effect on digital transformation.
- **H4:** Digital maturity plays a mediating role in the relationship between Enterprise Resource Planning (ERP) systems and digital transformation.

D. Research objectives

Based on the previously formulated research problem and hypotheses, this study primarily aims to examine the effect of the ERP system on achieving digital transformation, with a focus on the mediating role of digital maturity in the context of Sonatrach – Hassi R'Mel. From this overall aim, a set of more specific objectives can be derived, including:

- To identify the effect of the ERP system on achieving digital transformation in the company under study, and to determine the extent to which this system, as a technological tool, contributes to driving digital change.
- To measure the contribution of the ERP system to raising the level of digital maturity among organizational actors, and to clarify the relationship between system efficiency and the organization's readiness for digital transformation.
- To shed light on the role of digital maturity as a fundamental and direct driver of digital transformation processes, and to highlight the importance of organizational and human aspects alongside the purely technical dimension.
- To test the mediating role of digital maturity in the relationship between the ERP system and digital transformation, in order to determine whether the system leads to transformation directly, or mainly through developing the organization's capabilities (maturity).

- To provide practical recommendations to the company's decision- makers on how to maximize the benefits of the ERP (SAP) system in accelerating the pace of digital transformation, based on the results of structural equation modeling.

E. Research significance

The significance of this study stems from the importance of its key variables, where the independent variable is represented by the Enterprise Resource Planning (ERP) system, while the dependent variable is digital transformation, with digital maturity positioned as a mediating variable linking technology and organizational outcomes. Accordingly, the main points that reflect the significance of this research can be summarized as follows :

- Shedding light on one of the contemporary and critical topics in management and information systems, namely the role of ERP systems in driving digital transformation, and linking it to the concept of digital maturity in large industrial organizations.
- Responding to a real practical need within the Algerian energy sector, particularly in Sonatrach, which is undergoing a broad digital transformation process and requires empirical evidence on how to better exploit ERP systems such as SAP.
- Contributing to the development of theoretical and applied understanding of the relationship between technological infrastructure (ERP), organizational readiness (digital maturity), and strategic outcomes (digital transformation) in complex industrial environments.
- Providing field results that can be used by managers at Sonatrach – Hassi R'Mel to improve the way ERP systems are managed and to strengthen the human and organizational dimensions that support successful digital transformation.

F. Delimitations of the study

- **Spatial delimitation:** Sonatrach, Hassi R'Mel Directorate (HRM).
- **Temporal delimitation:** The fieldwork and data collection were conducted during the period from **28 February to 7 March 2026.**
- **Thematic delimitation:** The study is thematically restricted to analyzing the effect of the ERP system on digital transformation, with a specific focus on the mediating role of digital maturity. In this regard, the research concentrates on measuring:
    - the impact of the ERP system on both digital maturity and digital transformation,
    - the role of digital maturity as an intermediate organizational capability that channels the effect of ERP towards actual digital transformation within Sonatrach – Hassi R'Mel.

G. Research difficulties

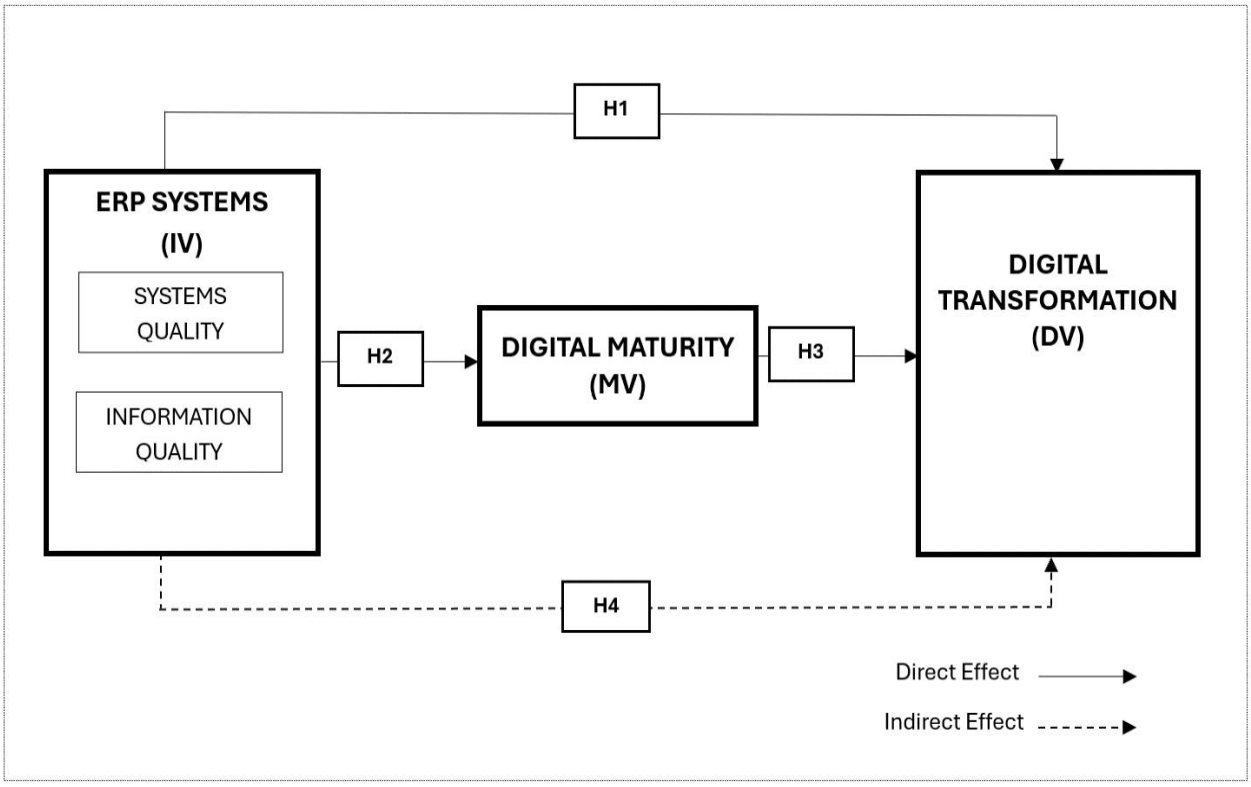
- The study faced logistical challenges due to the geographical distance to the Hassi R'mel site, requiring additional effort for travel and field follow-up.
- The researcher aimed to expand the sample size, but the internship period coincided with most employees being on leave, limiting the number of available participants.

- The research encountered a scarcity of Arabic studies that jointly examined ERP systems and digital transformation.

H. The research model

The research model clarifies the relationships between the study variables and shows how the ERP system influences digital transformation, while highlighting the mediating role of digital maturity. It explains the mechanism through which a technological system (ERP) contributes to building organizational and human readiness (digital maturity), which in turn drives and strengthens the overall digital transformation within Sonatrach – Hassi R'Mel

Figure 1 : Research model



Source: Prepared by the student

I. operational definitions

ERP system (Enterprise Resource Planning):

In this study, the ERP system means the SAP system used at Sonatrach – Hassi R'Mel to run daily work (such as operations, purchasing, finance and logistics) in one integrated digital system instead of separate, manual tools.

Its main dimensions are :

1) **System quality:** How well the SAP system itself works (speed, reliability, ease of use, interface clarity, system stability).
2) **Information quality:** How good the data and reports from SAP are (accuracy, completeness, timeliness, relevance for decision- making).

Digital maturity:

Digital maturity means how ready the organization and its employees are to work in a digital way, using systems like SAP instead of paper. It reflects the level of digital skills, the use of digital tools in daily tasks, and the degree to which processes are standardized and supported by technology.

Digital transformation:

Digital transformation means the change from traditional, paper- based and fragmented work methods to faster, more integrated digital processes supported by SAP. It appears in better efficiency, quicker information flow, more automation and improved services inside Sonatrach – Hassi R'Mel.

FIRST: LITERATURE REVIEW

1. Background

2. Enterprise Resource Planning Systems (Erp)

3. Digital Transformation

4. Digital Maturity

5. Previous Studies

1. FIRST: LITERATURE REVIEW

Background

ERP systems are among the fundamental pillars that modern organizations rely on to achieve information integration and enhance performance. Given the global shift toward digitalization, these systems emerge as a pivotal strategic tool for driving digital transformation by converting data into intelligent decisions that ensure organizational sustainability in a fast-paced digital business environment.

1.1 Enterprise Resource Planning Systems (ERP)

The rapid technological developments in the contemporary business environment serve as a primary driver for organizations to adopt digital solutions that ensure efficiency and sustainability. In this context, Enterprise Resource Planning (ERP) systems emerge as a cornerstone of digital transformation strategies, which will be discussed in detail through the following elements:

1.1.1 Definition of Enterprise Resource Planning (ERP):

Enterprise Resource Planning systems are defined as:

> Enterprise Resource Planning (ERP) is a software solution that integrates many fundamental company operations and services into a single platform. The main objective of an ERP system is enhancing efficiency, and facilitates data-driven decision-making within an organization. ERP systems typically cover a range of functions including finance, human resources, supply chain management, manufacturing, customer relationship management, and more.(Shrivastava & Lachhwani, 2025, p. 344)

- **It can also be defined as**: "The ERP is an integrated system that enables the company to standardize its information system in order to connect and automate its core processes. It provides employees with the necessary information to guide and control the company's essential activities along the supply chain, from procurement to production/operations, all the way to sales and delivery to the final customer."(Amel CHAABOUNI, 2006, p. 4)
- **Another definition:** Enterprise resource planning systems are management information systems that integrate and automate many of the business practices associated with the operations or production aspects of a company. (Alfonso & Mendoza, 2005, p. 9)

In light of the foregoing, Enterprise Resource Planning (ERP) systems can be viewed as integrated information platforms through which the various data of an organization's departments are centralized within a single platform, enabling data accuracy and consistency and enhancing operational efficiency, which leads to faster decision-making thanks to real-time visibility across different functional units.

1.1.2 Benefits of ERP Systems :

- Contributing to the enhancement of the company's various operations through clarifying, improving, and monitoring major key business processes such as procurement, customer offers and complaints, maintenance, marketing activities, and

other related processes. Improvement in decision making through more accurate and real-time data.

- Providing employees with instant access to data, documents, and reports related to their tasks, in addition to simplifying communication and the exchange of various critical information across the entire organization.(Tambovcevs & Tambovceva, 2022, p. 17)
- Enabling all stakeholders to have a comprehensive and clear view of how each department performs and its role in the overall activities of the organization.
- The system ensures scalability over time to suit the organization's growth and development.(IBM, 2026)
- Enabling the avoidance of information duplication across different departments within the organization by entering data only once, which is then used by all system applications.
- Supporting the security of the organization's data and applications through equipment centralization and monitoring.
- Creating a link between the organization and its partners in the supply chain, which contributes to connecting and exchanging information in real time.(Kechat, 2018, pp. 91–92)

1.1.3 The Requirements for The Successful Implementation of The ERP System:

Change Management: Change management represents the main tool that enables management and the organization as a whole to deal with various modern transformations. It is considered one of the best methods for implementing any change within the organization, with the aim of achieving the desired objectives.(Al-Zoubi, 2009, p. 77)

Training Employees: One of the conditions for the success of the new Enterprise Resource Planning (ERP) system is that the organization must provide specialized training courses according to the roles of all involved parties, which enables the system to be implemented correctly and smoothly across the entire organization.(George DelPrete, 2024)

Top Management Support: Top management support is considered one of the most important conditions for the implementation of the system and has a positive impact on the ERP implementation process. In addition, top management should enhance awareness of the importance of this system by communicating with employees and explaining its advantages and benefits. Moreover, top management support is a continuous process that is not limited only to the initiation stage. (Al-Mashari et al., 2006).

Vendor Support: Vendor support is considered one of the most important factors for the success of ERP system implementation, as selecting the appropriate vendor enables the organization to benefit from various services such as technical support and training throughout the system implementation phase. In addition, sharing vendors expertise with system users is of great importance, and vendor support remains the most influential factor throughout the entire implementation process.

User Involvement: The process of involving employees in the implementation of a new ERP system helps them better understand the system and provide useful feedback. It aims to reduce their concerns about transitioning from one situation to another, whether regarding their job security or their ability to operate correctly in the new environment, and to minimize their resistance.

Moreover, implementing an ERP system without adequate and proper employee involvement may lead to unsatisfactory results, as it is a complex information system that requires highly precise training.

Business Process Re-engineering (BPR): Business Process Reengineering (BPR) is one of the key factors for the successful implementation of an ERP system, as it helps improve and adapt processes to align with the organization's goals. Successful implementation requires adequate employee training, adopting flexible solutions, and minimizing system modifications to ensure operational efficiency, reduce errors, and maximize the benefits of the system.(Altamony et al., 2016, pp. 692–693)

1.1.4 Challenges In ERP Implementation:

- **Lack of Change Management and Training:**

One of the most common factors in the ERP system implementation process is resistance to change, which makes the presence of a well-structured change management strategy extremely important to prepare employees for the transition from one situation to another. This includes appointing a change manager who proactively addresses concerns and is capable of effective communication, thereby making the system more acceptable to users.

A well-designed training program can also contribute to a smooth transition from old systems to modern ones.

- **Inadequate Ongoing Support and Communication:**

Support and maintenance are essential for addressing potential issues once the ERP system becomes operational. Additionally, having dedicated teams ready to communicate and resolve problems can prevent work disruptions and maintain productivity.(Gupta, 2025, p. 925)

- **Data Migration Complexity:**

Data migration errors can jeopardize the overall success of the system implementation, as the process of migrating data from the current system to the new one is highly complex and full of challenges.

- **Project Management Challenges:**

Project management faces multiple challenges, such as scope creep, resource allocation, communication issues, and stakeholder management, which can hinder project progress and expected outcomes. Therefore, effective project management becomes one of the most important factors for the success of the ERP system. (Dynatech Systems, 2026)

- **Misalignment with Business Processes :**

An organization may not fully benefit from the system when its business processes are misaligned with it. Therefore, it is essential to understand the company's business processes before selecting an ERP system.(simpleter, 2026)

1.2 Digital Transformation

In light of the Fourth Industrial Revolution, digital transformation is no longer merely a technical option but has become a strategic necessity aimed at reshaping business models and enhancing organizational performance. This will be discussed in detail through the following elements:

1.2.1 Concept of Digital Transformation :

Digital transformation is defined as:

- "Digital transformation refers to the integration of digital technology into all aspects of business, resulting in a fundamental change in how businesses operate and give value to their customers".(Remmache & Bellal, 2024, p. 50)

- "Digital transformation (DX) is the integration of digital technology in all areas of a company's operations. This leads to huge changes in its functioning and can also significantly affect customer satisfaction and product quality. Thanks to DX, new, innovative products and services are cropping up".(BRAINHUB, 2025)

- "Digital transformation is a business strategy initiative that incorporates digital technology across all areas of an organization. It evaluates and modernizes an organization's processes, products, operations and technology stack to enable continual, rapid, customer-driven innovation".(Mark et al., 2026)

- "Digital transformation can be defined as the process of transitioning from handling files, documents, and information in a classical manner to adopting a faster and more accurate method using technological communication means that contribute to accelerating administrative processes and information transfer, overcoming time and distance barriers".(Hatem, 2024, p. 230)

Based on the previous definitions, we conclude that Digital Transformation is: the integration of digital technologies and their use across all organizational operations by leveraging digital data and converting it into value-added information, with the aim of accelerating operational processes and achieving high agility.

1.2.2 Digital transformation technologies :

The technologies of digital transformation include:

- **Big Data Technology:** Big data represents a collection of interconnected and complex databases extracted from multiple sources, which cannot be processed using traditional methods. This term emerged with the rise of the Internet of Things, applications, and smartphones, and a large portion of this data is unstructured, such as images and videos. This significant increase in data volume has also led to the emergence of "metadata," which represents information about other data, and "hyperdata," which covers a wide range of data and its related information. (Omar & Nacer, 2023, p. 232)

- **Artificial Intelligence (AI):** This technology revolves around enabling machines to perform intelligent tasks. From a business perspective, artificial intelligence allows devices the ability to make decisions based on available data, thereby enhancing the chances of success in specific areas.(Omar & Nacer, 2023, p. 233)
- **Cloud Computing:** It is a technology used to provide computing services such as storage, networking, software, and applications through the cloud, allowing access to all resources on demand without the need to own physical infrastructure. This technology is used to reduce costs and enhance flexibility and efficiency for all users.
- **Internet of Things (IoT):** It refers to a network of interconnected technological devices that enable communication between the devices and the cloud, as well as among themselves, allowing these devices to collect data, analyze it, and execute processes in an automated and integrated manner. (Gourine & Benghalia, 2025, p. 515)
- **Blockchain:** refers to a digital ledger that records transactions in real-time and is not limited only to financial transactions, but rather all transactions across various fields and sectors, as well as anything of value. (Ugle, 2022, p. 2).
- **Cybersecurity:** refers to a set of technologies aimed at protecting computers, networks, software, and data from any potential threat. This field has become heavily reliant on Machine Learning—a core component of Artificial Intelligence (AI) which plays a pivotal role in analyzing data and extracting information that helps us predict threats before they occur (Khalfallah & Bendjelloul, 2023, p. 781)

1.2.3 IMPORTANCE OF DIGITAL TRANSFORMATION :

- Digital transformation enables companies to establish customer relationships across the world without the need for a physical presence in different countries, and digital platforms also contribute to expanding the scope of global reach and spread.
- Helping in value creation through enabling digital platforms to interact with customers and analyze their behavior, as value is also created through the Internet of Things (IoT), customer participation, and the sharing economy.
- Digital transformation involves the transition from traditional processes that rely on paper to digital systems, and this includes recording information, storing it, retrieving it, and transmitting it digitally, which contributes to the speed of decision-making and increasing efficiency. (Hassani & Nacer, 2023, p. 231)
- Companies are undertaking digital transformation initiatives in order to shorten the time to market for their products, maintain their competitiveness, and enhance the customer experience.(Bouabdellah, 2022, p. 73)
- Accelerating the execution of daily tasks and increasing the efficiency and quality of operations.
- Enabling the use of modern technologies to improve the organization’s ability for forecasting and future planning. (Khantit, 2025, p. 157)
- Organizations that adopt digital transformation are distinguished from other organizations by offering innovative and creative services that go beyond traditional methods, providing them with a competitive advantage and creating new opportunities

- Enabling companies to achieve transparency by monitoring performance in real time, which increases the clarity of operations, while also facilitating access to information and ensuring the clarity of procedures for all stakeholders.(Ben Ahmed & Ben Ahmed, 2025, p. 505)

1.2.4 Challenges of Digital Transformation :

Digital transformation faces numerous challenges represented in :

- **Conceptual Ambiguity :**Many organizations still lack a clear and holistic understanding of digital transformation, which highlights the need for conceptual clarity and a solid intellectual foundation.
- **Resistance to Change :**Organizations face resistance to change from users when implementing the changes required by digital transformation, such as restructuring departments, redefining roles and responsibilities, and introducing leadership and functional adjustments.
- **Security Challenges:** Cyber risks have intensified as the interconnectedness among companies, communities, and countries has grown through reliance on digital technologies for storing, processing, and transmitting information; thus, cyber threats, especially electronic attacks, have come to pose significant risks to information security(Loucif, 2025, p. 102).
- **The lack of technical skills:** Among the fundamental factors that constitute an obstacle to digital transformation is the lack of technical skills among individuals working in the organization, such that this factor must be taken into account when formulating a digital strategy.
- **Organizational Culture:** which refers to the beliefs, values, and norms of the employees, and can constitute an obstacle to digital transformation if they are not open to the change process.
- **Laws and regulations:** Laws and regulations often constitute an obstacle to the effectiveness of digital transformation, leading to delays in its implementation and reducing its outcomes and positive impacts on the institution’s performance and profitability(Arribi & Boutarfa, 2024, p. 43).

1.3 DIGITAL MATURITY:

Digital maturity reflects the organization's readiness to integrate modern technologies and achieve a competitive advantage. Accordingly, this section focuses on the following two elements:

1.3.1 Concept of Digital Maturity:

This item provides a brief overview of the definitions of the concept of digital maturity found in the literature. The following are the main definitions that help clarify this concept in the context of the present study **:**

1) Digital maturity – how organizations systematically prepare to adapt consistently to ongoing digital change. Digital maturity draws on a psychological definition of "maturity" that is based upon a learned ability to respond to the environment in an appropriate manner(Aslanova IV & Kulichkina AI, 2020, p. 443).
2) Digital maturity is simply about adapting the organization to compete effectively in the increasingly digital environment [8]. Digital maturity models aim to provide both the level of digitalization of businesses and a wayto reach digital maturity. Planning the process by creating a prioritization and roadmap is an indispensable requirement in order for the digital transformation to be carried out in a healthy way and to reach the determined targets within the stipulated time(Kalender & Žilka, 2024, p. 904).
3) Digital maturity refers to an organization's readiness and capability to adopt, manage, and optimize digital technologies to enhance operational efficiency, foster innovation, and achieve sustainable competitiveness (Westerman et al., 2015). It reflects how digital technologies are strategically embedded within business operations to generate added value(Wahdaniyah et al., 2025, p. 603).
4) Digital Maturity refers to an organization's ability to quickly respond to the developments and shifting trends of technology. The focus is on creating value through these new capabilities and consumer interests fast enough to have a competitive advantage over rivals. Digital Maturity requires investment in the tools and human resources that can best leverage new technology(Dieffenbacher, 2022).

1.3.2 DIMENSIONS OF DIGITAL MATURITY:

The dimensions of digital maturity are:

- **Digital Technology :**

This dimension focuses on how modern, secure, and efficient the organization's digital systems and equipment are. It includes the shift from traditional on- premise systems to more advanced digital solutions, such as cloud computing and scalable systems that can grow as needed. It also relies on indicators like system stability, speed of updates, and the success of changes to assess how well technology supports daily work in a continuous and effective way.(Ilic, 2025)

- **Digital Strategy:**

It refers to the clear vision and plan established by the organization to utilize technology in achieving its long-term goals. This dimension goes beyond merely acquiring hardware and

software; it focuses on how to adapt these digital tools to improve services and develop employees' skills. This strategy is characterized by flexibility and the ability to evolve, keeping pace with rapid changes in the digital market, ensuring faster and more accurate decision-making based on available data(Abdelqader & Abdallah, 2023, p. 18)

- **Digital Operations :**

This dimension reflects the organization's ability to transform its resources (such as materials, funds, and information) into final products or services with maximum efficiency using technology. It involves digitizing the "workflow," ensuring that all activities and work procedures are fully supported by digital tools. Within this dimension, smart technologies play a crucial role in simplifying and accelerating core processes, such as production and logistics, thereby enhancing the organization's overall performance (Abdelqader & Abdallah, 2023, p. 19)

- **Digital Culture:**

Digital culture is the way technology mixes with how people act. Today, technology is not just a tool; it is a part of our daily life that changes how we think and talk to each other. For companies, this culture means using new ideas and facts to make better choices. The most important part is the people. Success in the digital world is not just about having good computers; it is about having people who are ready for change and know how to use technology to reach their goals in the best way(Abdelqader & Abdallah, 2023, p. 20)

1.4 Relationships between the study variables in light of the theoretical framework

Based on the previously presented concepts of the study variables, it becomes clear that Enterprise Resource Planning (ERP) systems represent the fundamental technical backbone that can support the digital transformation trajectory within the organization by providing process integration, unified databases, and improved information quality for decision-makers**. Kerbache Rahma (2024)**, drawing on the SAP S/4HANA platform, confirmed that modern ERP systems constitute a "digital core" that enables organizations to embark on digital transformation initiatives and enhance their operational efficiency.

In contrast, digital maturity is viewed as the level of an organization's readiness in terms of digital infrastructure, skills, organizational culture, and data utilization, which makes it a linking element between technical capabilities and strategic transformations. **Nasiri et al. (2022)** highlighted that digital maturity plays a central role in explaining the success of digital transformation initiatives, showing that organizations with higher levels of digital maturity are more capable of converting technological investments into tangible outcomes in terms of performance and transformation.

Accordingly, ERP systems are assumed, at the theoretical level, to influence digital maturity by improving system quality, information quality, and data integration, thereby strengthening organizational capabilities and digital skills within the firm. Digital maturity, in turn, contributes to creating a favorable environment for the success of digital transformation

projects by increasing organizational readiness and promoting flexible, data-driven work practices, as indicated by several studies on digital maturity models and their relationship with transformation.

- ✓ From this standpoint, the theoretical model of the present study assumes a direct effect of ERP systems on digital transformation, a direct effect of ERP systems on digital maturity, and a direct effect of digital maturity on digital transformation. It is further assumed that digital maturity plays a mediating role that explains how the effect of ERP systems moves from the technical level to the level of strategic transformation, such that the full impact of ERP systems on digital transformation is only realized under appropriate levels of digital maturity within the organization. This is consistent with recent literature that considers ERP systems as the "backbone" of digital transformation, while digital maturity represents the organizational condition required to maximize this impact.

1.5 PREVIOUS STUDIES

1.5.1 Previous Studies in Arabic

Table 1: Summary of Previous Studies in Arabic

Study: Radouane Bouzoualegh & Fouaz Oudah (2020)	
Study TITLE	The contribution of Enterprise Resource Planning (ERP) system in enhancing the competitive advantage of the institution - Case study of SIDER – Annaba (in Arabic)
Study type	Journal article
Study goal	To demonstrate and analyze the extent to which the Enterprise Resource Planning (ERP) system contributes to enhancing the competitive advantage of the SIDER El-Hadjar Iron and Steel Complex in Annaba.
Methodology & tools	The study adopted a Case Study approach. It targeted a population of 80 users within the institution (representing 20% of the community). The primary data collection tools were Questionnaires and Interviews.
Key findings	• The ERP system contributes to enhancing the competitive advantage of the complex to a high degree. • Analysis of respondents' attitudes showed high levels across all dimensions of competitive advantage, except for the "Innovation" dimension, which showed a moderate level. • Implementation faces challenges such as mental/perceptual barriers, financial constraints, and a lack of local expertise.

Study: Kerbache Rahma (2024)	
Study TITLE	Digital transformation in business organizations based on SAP S/4 HANA program (in Arabic)
Study type	Journal article
Study goal	To highlight the contribution of the SAP S/4 HANA program, as a modern generation of ERP systems, in achieving digital transformation within business organizations by analyzing its technical capabilities.
Methodology & tools	The study adopted a Descriptive and Analytical approach. It relied on analyzing the specific nature and digital capabilities of the SAP S/4 HANA platform, such as in-memory computing and advanced analytics, to evaluate its impact on organizational performance.
Key findings	• SAP S/4 HANA capabilities, such as Artificial Intelligence and Machine Learning, enable organizations to gain intelligent insights and automation. • The system accelerates data processing through in-memory computing, allowing for faster real-time decision-making and improved operational efficiency. • The platform's advanced analytics help companies extract actionable insights from big data, enhancing their competitiveness in today's digital economy.

1.5.2 Previous Studies in English

Table 2: Summary of Previous Studies in English

Study: Khawla Adnani & Abdeldjalil Mokedem (2025)	
Study TITLE	The Impact of Digital Technology Adoption on Supply Chain Performance: A Case Study of Sonatrach
Study type	Journal article
Study goal	To examine the transformative impact of digital technology adoption (specifically IoT, Big Data analytics, and ERP systems) on supply chain performance within the context of Sonatrach, Algeria.
Methodology & tools	The study employed a quantitative, correlational research design. Data was collected via surveys from 150 supply chain management professionals at Sonatrach. Statistical analysis was conducted using Pearson's correlation and regression techniques.

Key findings	• There are significant positive correlations between the adoption of Big Data analytics and ERP systems with enhanced supply chain performance. • The results emphasize the critical role of data-driven decision-making and integrated systems in achieving operational excellence. • The study revealed vital areas for optimizing IoT deployment strategies to maximize their potential within the energy sector.
Study: Djaanine Sana & Mili Anfel (2024)	
Study TITLE	Establishing an Internal Audit Function and Integration with Odoo ERP in IECO Packaging
Study type	Master's Thesis in Management Sciences
Study goal	To explore the integration of internal audit functions into the Odoo ERP system for IECO COMPANY, aiming to improve operational efficiency, enhance internal control mechanisms, and ensure compliance with best practices in a digital business landscape.
Methodology & tools	The study adopted a Case Study approach conducted at IECO Packaging in Blida. The researchers compared Odoo's functionalities with established software and proposed organizational changes, such as adding an internal auditor role, to evaluate the system's suitability for optimizing audit processes.
Key findings	• Integrating internal audit within an ERP system like Odoo provides valuable insights for organizations seeking to enhance their audit functions. • The transition from fragmented digital tools to a unified ERP platform improves operational efficiency and strengthens internal control mechanisms. • Leveraging ERP systems effectively is crucial for maintaining compliance and achieving value-added audit results in the era of digitalization.
Study: Amani Salma Belhaouari (2024)	
Study TITLE	The role of Digital Transformation in Procurement and Supply Chain Management - A field study of several institutions in Tiaret.
Study type	Master's Thesis in Financial Management.
Study goal	To investigate the role of digital transformation across various stages of the supply chain, from procurement to delivery, within Algerian companies.

Methodology & tools	The researcher adopted a Qualitative approach by conducting Interviews with 16 employees from four Algerian companies: (Algeria Telecom, ETUS Tiaret, Naftal fuel branch Tiaret 614, and Sonelgaz Tiaret). Data was analyzed using Thematic Analysis.
Key findings	• Digital transformation leads to significant efficiency improvements by reducing lead times and minimizing costs through automation and data-driven decision-making. • Digitalization enhances transparency across all supply chain stages and highlights the importance of e-procurement in driving strategic supplier management. • The study recommended developing a more integrated digital Procurement & Supply Chain Management (PSCM) system, suggesting that leveraging an ERP system can contribute to a more unified and effective digital network.
Annika Nordlund (2023)	
Study TITLE	The role of the Enterprise Resource Planning (ERP) Systems in Digital Transformation – Guidelines and recommendations for a case study company
Study type	Master's Thesis in Business Administration.
Study goal	To support the digital transformation journey in a selected case study company, specifically focusing on the role of ERP system implementation within that journey.
Methodology & tools	The study adopted a Case Study approach for a Finnish family-owned company. Data collection methods included Document Analysis of the company's intranet and Semi-structured Interviews with members of the senior executive team.
Key findings	• The ERP system is identified as the foundational "backbone" and the first step in the digital transformation journey. • Integrating ERP with advanced technologies like Artificial Intelligence (AI) offers significant benefits, but success depends heavily on data harmonization and leadership. • Digital transformation requires a broad set of competencies beyond technical ERP skills, including change management, business process understanding, and strong leadership. • AI and automation were seen as essential future enablers for evolving the company's business model.
Study: Deniz Merdin, Filiz Ersoz & Harun Taskin (2023)	
Study TITLE	Digital Transformation: Digital Maturity Model for Turkish Businesses

Study type	Research Article.
Study goal	To develop a comprehensive model to determine the digital maturity level of businesses and to provide a framework for evaluating digital transformation processes through specific dimensions.
Methodology & tools	The study utilized a Quantitative approach. Seven scales (dimensions) were developed and applied to businesses in Turkey. Data analysis was performed using Explanatory Factor Analysis (EFA) and Validity Analysis to examine the reliability of the proposed digital maturity model.
Key findings	• The study successfully proposed a digital maturity model consisting of seven key dimensions: strategy, customers, employees, process management, technology and data management, organizational culture, and innovation. • The research model proved to be applicable and usable for businesses to assess their digital status and identify transformation opportunities. • The findings indicated that the developed scales offer significant opportunities for researchers and businesses to guide their digital transformation journeys more effectively.
Mina Nasiri, Minna Saunila & Juhani Ukko (2022)	
Study TITLE	Digital orientation, digital maturity, and digital intensity: determinants of financial success in digital transformation settings
Study type	Research Paper
Study goal	To investigate three relevant antecedents of digital transformation—digital orientation, digital intensity, and digital maturity—and their specific influences on the financial success of companies.
Methodology & tools	The study developed five hypotheses based on strategic management and digital transformation literature to find relationships between these variables and financial success. The methodology followed a Quantitative approach to analyze these determinants within digital transformation settings.
Key findings	• Digital orientation and digital intensity alone do not directly contribute to the financial success of companies. • Digital intensity acts as a negative moderator between digital orientation and financial success. • Digital maturity plays a crucial role as a mediator between digital orientation and financial success, as well as between digital intensity and financial success. • The research provides a deeper understanding of how these factors should be positioned to achieve actual financial gains during digital transformation.

1.5.3 Research Gap

Previous studies on Enterprise Resource Planning (ERP) systems have shown their importance in strengthening competitive advantage and improving operational efficiency and supply chain performance. For example, **Bouzoualegh and Oudah (2020)** demonstrated that the ERP system significantly supports the competitive advantage of the SIDER El-Hadjar complex in Annaba, while **Khawla Adnani and Abdeldjalil Mokedem (2025)** highlighted the positive role of digital technologies, including ERP systems, in improving supply chain performance at Sonatrach. **Djaanine and Mili (2024)** showed that integrating the internal audit function into the Odoo ERP system improves internal control and performance in a digital business environment. In addition, **Kerbache Rahma (2024)** examined SAP S/4HANA as a new generation of ERP systems that enables organizations to start their digital transformation through its advanced technical features, whereas **Annika Nordlund (2023)** described the ERP system as the "backbone" and first step of the company's digital transformation journey.

On the other hand, **Amani Salma Belhaouari (2024)** studied the role of digital transformation in improving procurement and supply chain management in several Algerian companies, and pointed to the importance of integrated systems such as ERP, but without testing quantitative relationship models. **Deniz Merdin et al. (2023)** developed a multi-dimensional digital maturity model to assess how ready businesses are for digital transformation, while **Mina Nasiri et al. (2022)** showed that digital maturity plays an important mediating role between digital orientation and digital intensity on the one hand, and financial success in digital transformation contexts on the other. However, these studies, taken together, did not directly examine the relationship between ERP systems and digital transformation in the energy sector, and did not test digital maturity as a mediating variable in this relationship, especially in the Algerian context and in hydrocarbon organizations with complex technical and organizational characteristics.

Based on the analysis of these previous studies, three main categories of research gaps can be identified in this field: a contextual gap, a methodological gap, and a conceptual (variables-related) gap, as follows.

1. **Contextual gap:**
   Most empirical studies on digital transformation, digital maturity, and ERP systems have been carried out in developed countries or in small and medium-sized private firms. By contrast, the Algerian context in general, and the hydrocarbon sector in particular, still lacks quantitative field studies that examine digital transformation in a large public enterprise such as Sonatrach, even though several reports indicate the existence of a noticeable gap in digital transformation maturity in this sector.
2. **Methodological gap**
   Methodologically, most previous studies have relied on descriptive statistics, qualitative case studies, or simple correlation and regression models to analyze the effects of ERP systems or to measure digital maturity, with limited use of structural equation modeling techniques such as PLS-SEM. In contrast, the present study uses a SEM-PLS approach (with SmartPLS) to estimate an integrated measurement model and structural model that

include both direct and indirect relationships between ERP, digital maturity, and digital transformation.

3. **Conceptual / variables gap**

   At the conceptual level, previous research has either focused on the impact of ERP systems on financial performance, competitive advantage, or operational efficiency, or has treated digital maturity as an independent variable linked to financial success or innovation, without combining these three elements in a single framework. This study is different because it proposes a model that links technology (ERP), organizational readiness (digital maturity), and strategic outcomes (digital transformation), and it tests the mediating role of digital maturity in this relationship in the specific context of Sonatrach – Hassi R'Mel Directorate (HRM).

Summary of the research gap

In summary, this study addresses the lack of advanced quantitative field models in the Algerian hydrocarbon sector that test the mediating role of digital maturity in explaining the effect of the ERP (SAP) system on digital transformation within Sonatrach – Hassi R'Mel Directorate (HRM). It does so by using SEM- PLS to build an integrated mediation model that clarifies how the effectiveness of the ERP system is translated into digital transformation outcomes through the level of digital maturity of human resources and organizational processes.

Field Study at Sonatrach – Hassi R'Mel Branch

Introduction

After constructing the theoretical and conceptual framework of the study variables in the previous part which included the independent variable (Enterprise Resource Planning systems ERP, with its dimensions: system quality and information quality), the dependent variable (digital transformation), and the mediating variable (digital maturity)—this chapter moves on to the empirical testing of the conceptual model and its hypotheses. It examines the direct and indirect impact relationships between these variables in the context of Sonatrach (Hassi R'mel Directorate), as one of the leading institutions that has adopted the SAP system as a tool to enhance its digital performance. To this end, the structural equation modeling approach using partial least squares (SEM-PLS) was employed, and the chapter is divided into three main sections:

SECOND: Methodological procedures of the field study: It addresses the identification of the adopted method, the description of the study population represented by the executives and employees of Sonatrach in Hassi R'mel, and the presentation of the study sample, along with reviewing the data collection tool (the questionnaire) and testing its psychometric properties in terms of validity and reliability, leading to the identification of the statistical methods adopted.

THIRD: Statistical Results of the Study : It focuses on the descriptive analysis of the personal and job-related data and the analysis of the sample members' attitudes toward the study variables, followed by the evaluation of the measurement model to ensure the quality of the measurement indicators, then the evaluation of the structural model to test the validity of the direct hypotheses and to determine the mediating role of digital maturity in the relationship between the ERP system and digital transformation.

FOURTH: Discussion of Results and Conclusions: In this section the field results will be interpreted and linked to the theoretical literature and previous studies, and then the most important conclusions will be drawn regarding how the efficiency of the ERP system contributes to accelerating the pace of digital transformation by enhancing the levels of digital maturity of the organization, with the study concluding by presenting practical recommendations to the officials of Sonatrach based on the statistical outputs.

2 SECOND: Methodological procedures of the field study

This section first presents a definition of the field institution (Sonatrach - Hassi R'mel Directorate), followed by the methodological and procedural framework of the field study, clarifying the course followed to ensure the accuracy of the statistical results. The topic includes identifying the adopted method as the methodological framework of the field study, followed by a description of the study population, the sampling method, and the final sample size. It also includes presenting the stages of constructing and designing the data collection tool. The topic concludes with specifying the statistical methods adopted.

Presentation of the study organization:

1: Definition of Sonatrach

Sonatrach is a national public company established in 1963 that operates in the hydrocarbons sector and is the main player in the oil and gas industry in Algeria. Its activities include exploration and production, transportation of hydrocarbons, refining and marketing. The company occupies a strategic position in the national economy, as it contributes significantly to state revenues, and it relies on modern information systems to improve performance and support decision- making.

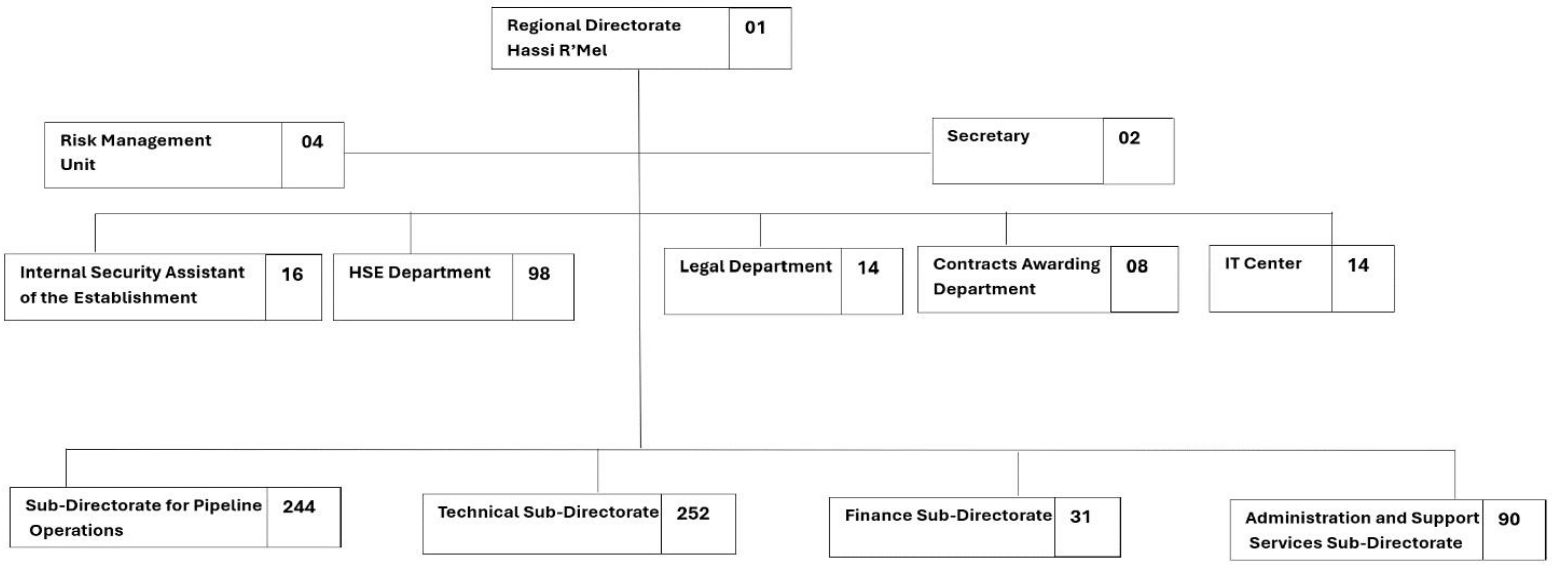
2: Hassi R'Mel regional directorate

The Hassi R'Mel regional directorate is part of Sonatrach's organizational structure and is located in the Hassi R'Mel area, which is one of the most important natural gas fields in Algeria. This directorate is responsible for supervising natural gas production and processing operations, ensuring continuity of production in line with technical and safety standards, and contributing to the achievement of the company's objectives at the local level.

3: The organizational structure of Hassi R'Mel:

The organizational structure is considered as the framework that shows the different managerial levels, as well as the main and sub organizational units and functions.

Figure 2 : Organizational structure of the Hassi R'Mel regional directorate



Source: Sonatrach, Hassi R'Mel regional directorate (official document)

2.1 Study method, population, and sample

This part addresses the fundamental pillars on which the methodological design of the field study was built. It covers three main points: we begin by identifying the scientific method adopted to achieve the objectives of the study, then move on to describing the targeted study population, and conclude by clarifying the characteristics of the selected sample, the way it was chosen, and its final size.

2.1.1 The method adopted in the Field study:

The study adopted the descriptive and analytical method due to its suitability to the nature of the problem, which is based on examining the effect among the study variables. It was employed at the following two levels:

1. **Descriptive level:** It was used to diagnose the reality of using the SAP system at the Sonatrach Directorate, to determine the levels of digital maturity and digital transformation among employees, in addition to describing the personal and job-related characteristics of the study sample.
2. **Analytical level:** This level was devoted to testing the study hypotheses, where structural equation modeling (SEM-PLS) was relied upon to measure and examine the relationships between the variables, and to determine the type and strength of the impact (direct and indirect) of the ERP system in achieving digital transformation, with digital maturity as a mediating variable.
   In this way, the adopted method provides a solid methodological framework that goes beyond superficial description to an in-depth analysis of the causal relationships between the study variables.

2.1.2 Study population and sample:

After identifying the scientific method that frames the steps of the field study, this part proceeds to define the human field to which the study was applied.

First: Study population: The study population consists of all executives and employees affiliated with the Sonatrach Directorate in Hassi R'mel who use the SAP system as a basic tool in performing their job tasks in the various administrative and technical departments. This population was chosen because it is the group most capable of assessing the quality of the ERP system and the extent of its actual contribution to digital transformation processes within the organization.

Second: Study sample: Given the nature of the study population, a **purposive sample** of SAP system users was relied upon, in order to obtain accurate data from those with direct experience with the system. The details of the sample are presented below.

Table 3 : Results of the Distribution and Return of Questionnaire Forms

Item	Distributed questionnaires	Returned questionnaires	Excluded questionnaires (incomplete)	Valid questionnaires for analysis (final sample)
Number	76	72	2	69
Percentage (%)	100%	94.81%	3.89%	90.91%

Source: Prepared by the student

The table above illustrates the procedural course of the field data collection, where the following can be noted:

- **High response rate:** The percentage of returned questionnaires reached about 94.81%, which is a very high rate that reflects the level of awareness and interest of the employees and executives of the Sonatrach Directorate in the subject of the study, as well as their commitment to contributing to scientific research.
- **Data accuracy:** Only 2 questionnaires were excluded because they did not meet the conditions of complete responses, in order to ensure the quality of the data and the validity of the subsequent statistical results.
- **Sample adequacy:** The final sample settled at 69 respondents, which is a sufficient and statistically acceptable sample for conducting the analysis using structural equation modeling (SEM-PLS). Methodological studies have shown that this approach is highly efficient in dealing with small to medium samples while maintaining statistical test power.

2.2 Data collection sources

To achieve the objectives of the study and to cover its variables from both the theoretical and field perspectives, the research relied on two types of sources:

2.2.1 Secondary sources (the theoretical framework)

These were used to build the scientific background of the study and to ground its concepts (ERP system, digital maturity, digital transformation). These sources include:

- **Scientific literature:** Books, articles published in refereed journals, and academic theses in both Arabic and foreign languages.
- **Previous studies:** A review of the most recent studies (2020–2025) that addressed the relationship between integrated systems and digital transformation, which helped in formulating the hypotheses and building the research model.
- **Internal documents:** Reports and publications of Sonatrach to identify the reality of SAP system use and the company's orientation toward digitalization.

2.2.2 Primary sources (the field study)

These were used to collect raw data from the practical reality in order to test the validity of the hypotheses. The main tool consisted of :

- **Questionnaire:** It was specifically designed as the main tool for the field survey and was administered to SAP users at the Sonatrach Directorate (Hassi R'mel). The questionnaire included carefully formulated statements to collect the sample's opinions and perceptions regarding system quality, the level of digital maturity, and the outcomes of digital transformation.

2.2.3 Construction of the questionnaire tool

The study tool (the questionnaire) was developed based on the theoretical frameworks of the (DeLone and McLean) Information Systems Success Model and the literature on digital transformation. The tool was designed to measure the variables that constitute the proposed conceptual model. In its final form, it consisted of three main axes, in addition to the general data section, as detailed below:

- **First section (general data):** Includes five classification variables for the study sample at the Sonatrach Directorate (gender, age, educational level, professional experience, and job category).
- **First axis (ERP system):** Represents the independent variable and consists of 12 items distributed over two dimensions: system quality (6 items) and information quality (6 items).
- **Second axis (digital maturity):** Represents the mediating variable and consists of 8 items distributed across four dimensions: **digital strategy**, **digital culture**, **digital processes**, and **digital technology**, which measure the organization's readiness, individuals' capabilities, and digital infrastructure.
- **Third axis (digital transformation):** Represents the dependent variable and consists of 6 items that capture three main outcomes: **digital business model**, **user experience**, and **administrative efficiency**.

The study adopted the five-point Likert scale (5-point Likert Scale) to determine the degree of response of the sample members, where weights were assigned from (1) for "strongly disagree" to (5) for "strongly agree," as shown in the following table.

Table 4: The Five-point Likert Scale Scoring and Interpretation Categories

Alternatives	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Weights	1	2	3	4	5
Mean (agreement range)	[1–1.80[	[1.81–2.60[	[2.61–3.40[	[3.41–4.20[	[4.21–5]

Source: Prepared by the student

The following table shows the distribution of the items across the dimensions and variables of the study:

Table 5: Structure of the Questionnaire and Distribution of Items Across Variables

Variables	Dimensions	Number of items	Item Numbers
Independent variable : ERP system	1.System Quality	6	01–06
	2.Information Quality	6	07–12
Mediating variable : Digital Maturity	Digital Maturity	8	13–20
Dependent variable : Digital transformation	Digital Transformation	6	21–26
Total Number of items		**26**	**01–26**

Source: Prepared by the student

2.3 Statistical methods used in data analysis

Selecting appropriate statistical methods is a fundamental methodological pillar in the analysis of any scientific research data, as the validity of the results and the accuracy of the analysis depend on it. This choice can only be sound after verifying a set of preliminary conditions, foremost among them identifying the nature of the distribution of the study data, and then determining whether parametric or non-parametric methods are more suitable for the analysis. The main methodological steps followed by the student in this regard are presented below.

2.3.1 Testing the nature of data distribution

Verifying the nature of the data distribution is an essential methodological step that cannot be omitted before applying statistical tests, as the choice of appropriate statistical methods depends on it. Parametric tests require that the data follow a normal distribution, whereas non-parametric tests do not require this condition. To verify whether the study data follow the normal distribution, the Kolmogorov–Smirnov test was used, as it is the most appropriate test for samples with a size of 50 observations or more,(Razali & Wah, 2011)

and its hypotheses are formulated as follows:

- Null hypothesis (H_0): The data follow a normal distribution.

- Alternative hypothesis (H_1): The data do not follow a normal distribution.

The result of the test is judged by comparing the significance value (Sig.) with the adopted significance level ($\alpha = 0.05$). If Sig. < 0.05, the null hypothesis (H_0) is rejected and it is concluded that the data do not follow a normal distribution. If Sig. ≥ 0.05, the null hypothesis (H_0) cannot be rejected and the data are considered to be normally distributed. The following table presents the results of this test for the study variables.

Table 6 : Kolmogorov–Smirnov Test Results for Normality of the Study Variables' Data

Variable	Kolmogorov-Smirnov (with Lilliefors Correction)			Judgment on distribution
	Statistic	df	Sig	
1.System Quality	0.178	69	0.000	Does not follow a normal distribution
2.Information Quality	0.162	69	0.000	Does not follow a normal distribution
Independent variable : ERP System	0.155	69	0.000	Does not follow a normal distribution
Mediating variable : Digital Maturity	0.110	69	0.036	Does not follow a normal distribution
Dependent variable : Digital Transformation	0.134	69	0.004	Does not follow a normal distribution

Source: Prepared by the student based on SPSS v.31 outputs.

The results of the Kolmogorov–Smirnov test shown in the table above reveal that the significance values (Sig.) for all the study variables are below the adopted significance level ($\alpha = 0.05$), and these results lead us to reject the null hypothesis (H_0) for all variables and to accept the alternative hypothesis (H_1), which states that the data do not follow a normal distribution.

Based on this result, it is not possible to use parametric statistical methods, which require normality of distribution as a basic condition for the validity of their results, and resorting to non-parametric tests thus becomes a methodological necessity rather than a choice. Accordingly, the student adopted the partial least squares structural equation modeling (SEM-PLS) approach, as it is one of the most appropriate statistical methods for non-normally distributed data, in addition to its ability to handle small and medium-sized samples and to test the relationships between independent, dependent, and mediating variables simultaneously within an integrated model, unlike linear regression models, which are limited to testing a bilateral relationship between two variables at a time and do not allow for the testing of mediating effects.

2.3.2 Identification of the statistical methods used in the study

To achieve the objectives of the study and answer its questions, a comprehensive set of statistical methods belonging to two different generations of data analysis techniques was used. The following table presents these methods, their purposes, and the software used to apply them.

Table 7 :Summary of the statistical methods used in the study

Generation	Statistical method	Purpose of use	Software used
First-generation Methods	Descriptive statistics :(frequencies, percentages, arithmetic means, standard deviations)	- To describe the demographic characteristics of the study sample. - To diagnose the general trends of the sample's responses toward the study variables.	**IBM SPSS Statistics V.31**
	Normality test (Kolmogorov–Smirnov)	To verify whether the data follow a normal distribution in order to justify the choice of the appropriate statistical method.	
Second-generation Methods	Partial Least Squares Structural Equation Modeling (SEM-PLS)	1. Evaluation of the measurement model: - Testing the reliability and internal consistency of the scale (CR, CA). - Testing the validity of the scale (convergent validity AVE and discriminant validity HTMT). 2. Evaluation of the structural model: - Testing the hypotheses of direct and indirect effects (mediating role). - Measuring the explanatory power of the model (R^2).	**SmartPLS V.4**

Source: Based on the following references consulted by the student.(George & Mallery, 2016; Hair et al., 2022; Al- Qahtani, 2015)

2.3.3 Conceptual framework of structural equation modeling (PLS-SEM) and justification for its use

After determining the nature of the data distribution and the statistical methods in general, this branch is devoted to presenting a conceptual framework of the advanced statistical method adopted in this study, **namely Partial Least Squares Structural Equation Modeling (PLS-SEM)**, and to justifying the reasons for its choice. In addition to first-generation techniques, which focus mainly on analyzing relationships between variables separately, recent decades have witnessed an increasing trend toward second-generation techniques that provide a deeper and more comprehensive understanding of complex phenomena. These techniques are characterized by their ability to examine an entire network of relationships among multiple variables simultaneously, thereby overcoming many of the weaknesses of first-generation techniques (Hair et al., 2022, p. 2) . In this context, the researcher adopted Partial Least Squares Structural Equation Modeling (PLS-SEM) as the main analytical tool.

2.3.3.1 Definition of structural equation modeling using partial least squares

Partial Least Squares Path Modeling (PLS Path Modeling), known as PLS, is a statistical analysis method used to analyze relationships among variables in complex structural models. This method was developed by Wold and his colleagues in 1966 and was further developed and extended in subsequent years by Lohmöller (1989). Wold (1982) referred to it as a "soft modeling" approach. PLS is considered a type of Structural Equation Modeling (SEM) and is used mainly in research that aims to understand the relationships among different variables within structural models. One of the most important features of PLS is its ability to handle non-normal or irregular data, which makes it preferable when it is difficult to meet the requirements of traditional SEM, such as normal data distribution. PLS uses ordinary least squares (OLS) regression to analyze the relationships among variables, and the aim of this method is to minimize the error (residual variance) in the dependent variables, thereby providing a well-fitting model that better explains the relationships among variables. One of the prominent characteristics of PLS is its ability to achieve high R^2 values for the dependent variables, which contributes to achieving the predictive goal of the model(هار وآخرون، 2020، ص. 23-25) . The following sections present the characteristics, stages, and statistical criteria for evaluating the hypothetical model of our study using SEM-PLS.

2.3.3.2 Stages, criteria, and statistical indicators for evaluating the study model according to SEM-PLS

The quality of the hypothetical model of the study and the testing of its hypotheses are evaluated in two stages:

- **First stage:** Evaluation of the measurement model (outer model): This stage involves evaluating and testing the correlational relationship between the study variables and their measurement items (statements), that is, the questionnaire items used to measure them. This is known as the evaluation of the measurement model of the study.
- **Second stage:** Evaluation of the structural model (inner model): This stage involves evaluating and testing the relationships among the study variables with one another within the model, and it is referred to as the evaluation of the structural model of the study.

Table 8 : Statistical Criteria and Indicators for Evaluating the Study Model Using SEM-PLS

The evaluation of the measurement model and the structural model using SEM-PLS
1.THE EVALUATION OF THE MEASUREMENT MODEL.
├── A. **Assessment of Convergent Validity:** • Indicator reliability criterion (Outer Loadings > 0.70). Threshold: The outer loading value of each indicator (item) on its corresponding construct must be greater than 0.70. • Average Variance Extracted criterion (AVE > 0.50). Threshold: The AVE value for each construct must be greater than 0.50. ├── B. **Assessment of Discriminant Validity**: • Cross- loadings criterion. Threshold: The outer loading of an indicator (item) on its associated construct must be higher than any of its cross- loadings on other constructs. • Fornell–Larcker criterion. Threshold: The square root of the AVE for each construct must be greater than its highest correlation with any other construct. • HTMT (Heterotrait–Monotrait Ratio) criterion. Threshold: The HTMT value should be less than 0.90 for conceptually similar constructs, and less than 0.85 for conceptually distinct constructs.

|—— C. **Assessment of Internal Consistency Reliability**:
- Cronbach's alpha criterion. Threshold: $\alpha > 0.700$.
- Composite Reliability (CR) criterion. Threshold: CR > 0.700.

2. Assessment of the Structural Model and Hypothesis Testing (STRUCTURAL MODEL).

| —— A. Assessing Collinearity Issues
Variance Inflation Factor (VIF) criterion: Thresholds: VIF ≤ 3: No collinearity problem. 3 < VIF ≤ 5: Potential collinearity problem. VIF > 5: Critical collinearity problem.
| —— B. Assessing the Coefficient of Determination (R^2)
Thresholds: $R^2 = 0.25$ (weak). $R^2 = 0.50$ (moderate). $R^2 \geq 0.75$ (substantial). Description: R^2 measures the proportion of variance in the dependent variable explained by the independent and mediating variables.
| —— C. Assessing Effect Size (f^2)
Thresholds: $f^2 = 0.02–0.15$ (small). $f^2 = 0.15–0.35$ (medium). $f^2 \geq 0.35$ (large). Description: Measures the individual impact of independent variables on the dependent variable.
| —— D. Assessing Predictive Relevance (Q^2)
Threshold: $Q^2 > 0$: Indicates good predictive relevance. Description: Q^2 measures the structural model's ability to predict future data.
| —— E. Assessing the Statistical Significance of Path Coefficients
Path Coefficient (β): Range: -1 to 1. Threshold: (p-value ≤ 0.05): Indicates statistically significant relationships. Interpretation: β values closer to -1 or 1: Indicate stronger relationships. β values close to zero: Indicate weaker relationships.

source: Prepared by the student based on: (J. F. Hair et al., 2019)

2.3.3.3 Justifications for using SEM-PLS in the present study

Based on the nature of the study and the characteristics of its data, Partial Least Squares Structural Equation Modeling (SEM-PLS) was adopted as the main statistical method for several reasons that can be summarized as follows:

- **Non-normal distribution of the data.** The Kolmogorov–Smirnov test showed that the data for all study variables do not follow a normal distribution, which hinders the use of covariance-based SEM (CB-SEM), as it relies on full-information likelihood and explicitly requires normality of distribution. In contrast, SEM-PLS does not impose any prior assumption regarding data distribution, which makes it the most appropriate methodological choice for this study.
- **Suitability of sample size.** The study sample consisted of 69 observations, which falls within the range of medium-sized samples. Research has demonstrated that SEM-PLS can achieve substantial statistical power even with small and medium samples, unlike CB-SEM, which generally requires large samples to ensure the reliability of the results.
- **Complexity of the study model.** The study model includes multiple variables comprising an independent variable (ERP system), a mediating variable (digital maturity), and a dependent variable (digital transformation), in addition to their sub-dimensions. SEM-PLS is distinguished by its ability to test these direct and indirect relationships simultaneously within an integrated model, which allows for a comprehensive assessment of the mediating effects that constitute the core of the study problem.
- **Predictive orientation of the study.** The essence of the study is to explain and predict the relationships among variables, and this objective is fully aligned with the main aim

of SEM-PLS, which is to maximize the explained variance (R^2) and achieve the highest possible predictive power for the model.

- **Nature of the measurement variables**. The study model is based on latent variables of a reflective type, which is the most common pattern in management and social science research, where the indicators (questionnaire items) reflect the latent construct to which they belong. SEM-PLS handles this type very efficiently through an integrated set of evaluation criteria, including convergent validity, discriminant validity, and composite reliability.

In light of all these justifications taken together, SEM-PLS represents the optimal choice when such characteristics converge in a single study, especially in information systems and business management research, where variables are intertwined and multiple levels of effects coexist.

3 THIRD: Statistical Results of the Study

After presenting the methodological procedures and describing the study instrument, this section is devoted to presenting the field results by processing the data of the sample consisting of 69 individuals. In this part, a detailed presentation and analysis of the field study results is provided, starting with a description of the personal and job-related characteristics of the sample members, then moving to the descriptive analysis of their attitudes toward the study variables in Sonatrach, and finally evaluating the model and testing the hypotheses. For this purpose, IBM SPSS Statistics V.31 was used for the descriptive analysis, and SmartPLS V.4 was used for model evaluation and hypothesis testing according to the SEM-PLS methodology.

The statistical results obtained from this analysis, whether leading to the acceptance or rejection of the hypotheses, constitute the main basis for the discussion and interpretation of the results and the formulation of practical recommendations in this study.

3.1 Presentation and analysis of the study data

3.1.1 Descriptive analysis of the personal and job-related data of the study sample

This branch describes the demographic and job-related characteristics of the study sample, which consists of 69 respondents, using frequencies and percentages for the five classification variables.

Table 9 : Frequency distribution of the personal and job-related data of the study sample

Variable	Category	Number (N)	Percentage (%)
Gender	Male	57	82.6%
	Female	12	17.4%
Age group	Less than 30 years	13	18.8%
	From 30 to 45 years	46	66.7%
	More than 45 years	10	14.5%
Educational level	University degree	61	88.4%
	Postgraduate studies	8	11.6%
Professional experience	Less than 5 years	18	26.1%
	From 5 to 10 years	34	49.3%
	More than 10 years	17	24.6%
Job category	Senior executive	6	8.7%
	Middle executive	51	73.9%
	Operational employee	12	17.4%

Source: Prepared by the student based on SPSS v.31 outputs.

The results of the frequency distribution of the characteristics of the study sample show the following:

- With regard to **gender**, males represent 82.6% (57 individuals) compared to 17.4% for females (12 individuals), which reflects the male-dominated nature of the working environment in the petroleum sector at Sonatrach.
- In terms of **age** group, the category 30–45 years accounts for the largest proportion with 66.7% (46 individuals), followed by the group less than 30 years with 18.8% (13 individuals), while the group over 45 years represents 14.5% (10 individuals), indicating that most respondents are in the mid-career stage.
- At the **educational level**, the proportion of those with a university degree reached 88.4% (61 individuals), compared to only 11.6% holding postgraduate degrees (8 individuals), which reflects the high qualification level of the organization's executives and employees.
- Regarding **professional experience**, the 5–10 years category accounted for 49.3% (34 individuals), followed by less than 5 years with 26.1% (18 individuals), and more than 10 years with 24.6% (17 individuals), indicating that most respondents have practical experience that enables them to evaluate the SAP system objectively.
- At the **job category level**, middle executives represent the majority with 73.9% (51 individuals), while operational employees account for 17.4% (12 individuals), and senior executives represent 8.7% (6 individuals), which is consistent with the hierarchical job structure of Sonatrach.

3.1.2 Descriptive analysis of the study variables

This part presents the response levels of the sample members to the items and variables of the study by calculating the arithmetic means to determine the respondents' attitudes and the standard deviations to measure the degree of dispersion or homogeneity of the answers, as shown in the following table.

Table 10 : Statistical description of the sample's attitudes toward the study variables and items (N = 69)

Item code	Item	N	Min	Max	Mean	Std. dev.	Agreement level
Independent variable: ERP system – Dimension 1: System quality							
QS1	The ERP system interface is simple and easy to use	69	2	5	3.67	1.024	Agree
QS2	Access to menus and data is easy	69	2	5	3.90	0.877	Agree
QS3	The system links all departments efficiently	69	1	5	4.07	0.810	Agree
QS4	Tasks are coordinated to form a unified workflow	69	1	5	3.80	0.797	Agree
QS5	The system can handle a large workload	69	3	5	4.04	0.580	Agree
QS6	The system operates smoothly without interruptions	69	2	5	3.78	0.968	Agree

System quality – total		69	2.50	5.00	3.8768	0.56567	Agree
Independent variable : ERP system – Dimension 2: Information quality							
QI1	The system provides accurate and correct information	69	2	5	4.13	0.784	Agree
QI2	Reports produced by the system are free of errors	69	1	5	3.72	1.042	Agree
QI3	The system provides information in real time	69	1	5	3.94	0.873	Agree
QI4	The system provides information at the right time for decision-making	69	2	5	3.97	0.840	Agree
QI5	Information is presented clearly and understandably	69	1	5	3.65	1.041	Agree
QI6	Available data cover all work needs	69	1	5	3.12	1.051	Moderate
Information quality – total		69	2.33	5.00	3.7560	0.63566	Agree
ERP system – overall total		69	2.58	5.00	3.8164	0.54413	Agree
Mediating variable : Digital Maturity							
MN1	The organization has a clear digital transformation plan	69	2	5	3.58	0.930	Agree
MN2	Management strongly supports the use of digital systems	69	1	5	3.71	0.925	Agree
MN3	The organization encourages employees to accept change	69	1	5	3.36	1.029	Moderate
MN4	There is sufficient awareness of the importance of digitalization	69	1	5	3.64	0.840	Agree
MN5	The organization prefers electronic transactions over paper-based ones	69	1	5	3.33	1.120	Moderate
MN6	Work is carried out entirely on the system without manual records	69	1	5	2.86	1.167	Moderate
MN7	The organization provides appropriate equipment and networks	69	2	5	3.93	0.734	Agree
MN8	Current digital tools reduce human effort	69	1	5	3.51	0.964	Agree
Digital maturity – total		69	2.00	5.00	3.4891	0.60624	Agree
Dependent variable : Digital transformation							
DV1	The ERP system enabled the provision of more advanced services	69	2	5	4.10	0.789	Agree
DV2	The ERP system created innovative ways of working	69	2	5	3.80	0.850	Agree
DV3	The system provides clear interfaces for task completion	69	1	5	3.74	1.038	Agree
DV4	Employees are satisfied with the efficiency provided by the system	69	2	5	3.26	0.816	Moderate
DV5	The ERP system has simplified administrative work procedures	69	1	5	3.52	1.066	Agree
DV6	The ERP system has accelerated task exchange between departments	69	2	5	3.77	0.957	Agree
Digital transformation – total		69	2.00	5.00	3.6981	0.69090	Agree

Source: Prepared by the student based on SPSS v.31 outputs

By examining the results of the table above, the following analytical readings emerge:

The independent variable (ERP system); It recorded a relatively high overall mean of 3.81, which reflects a general tendency to agree on the efficiency of the SAP system at the Hassi R'Mel Directorate. The "system quality" dimension stood out as the strongest, with an average of 3.87, where employees clearly perceive the system's ability to "link departments" (QS3, mean = 4.07) and to withstand "workload pressure" (QS5, mean = 4.04), which is consistent with the technical requirements of Sonatrach.

The mediating variable (digital maturity): It posted a mean of 3.48, which indicates a "good/agreeable" level of maturity. It is noted that the organization has made significant progress in providing "equipment and networks" (MN7, mean = 3.93), while the move toward "fully digital work without manual records" (MN6, mean = 2.86) still represents an organizational challenge that requires more time before completely abandoning paper.

The dependent variable (digital transformation): It achieved a mean of 3.69, indicating that the ERP system has effectively contributed to "delivering more advanced services" (DV1, mean = 4.10) and developing "innovative ways of working" (DV2, mean = 3.80). This confirms the pivotal role of the SAP program as a solid launch pad for digital transformation in the organization.

Overall conclusion: The above analysis shows that all the study variables enjoy a high level of agreement from the sample members; the overall means reached 3.81 for the ERP system, 3.48 for digital maturity, and 3.69 for digital transformation. These positive descriptive results form a basis for embarking on a more in-depth and precise analysis. Despite the clear levels of satisfaction and awareness among Sonatrach employees regarding the SAP system, these indicators remain preliminary impressions (opinions and attitudes) that do not allow us to be certain about the strength of the actual impact relationships between the variables in the study model.

Accordingly, and in order to achieve the aim of the field study, the analysis moves from the level of "descriptive diagnosis of the organizational reality" to the level of "inferential testing of relationships" through the Structural Equation Modeling technique (SEM-PLS). This will allow, first, verification of the quality of the measurement model, and second, assessment of the strength of effects in the structural model. This leads us to the core question that the next section will seek to answer:

- **To what extent are these positive descriptive results translated into impact relationships between ERP system efficiency and the achievement of digital transformation, and what is the actual role played by digital maturity as a mediating variable in strengthening this relationship?**

3.2 Model evaluation and hypothesis testing

After presenting a descriptive and diagnostic overview of the reality of the study variables based on the respondents' answers, this section moves to the advanced analytical stage, which focuses on evaluating the study model and testing its hypotheses.

Partial Least Squares Structural Equation Modeling (SEM- PLS) was employed using the SmartPLS 4 software to examine the impact relationships between the study variables through two integrated stages: first, evaluating the **measurement** model to verify the validity and reliability of the model, and second, evaluating the **structural** model to test the hypotheses and identify the nature of the direct and indirect relationships between the variables.

3.2.1 Evaluation of the measurement model

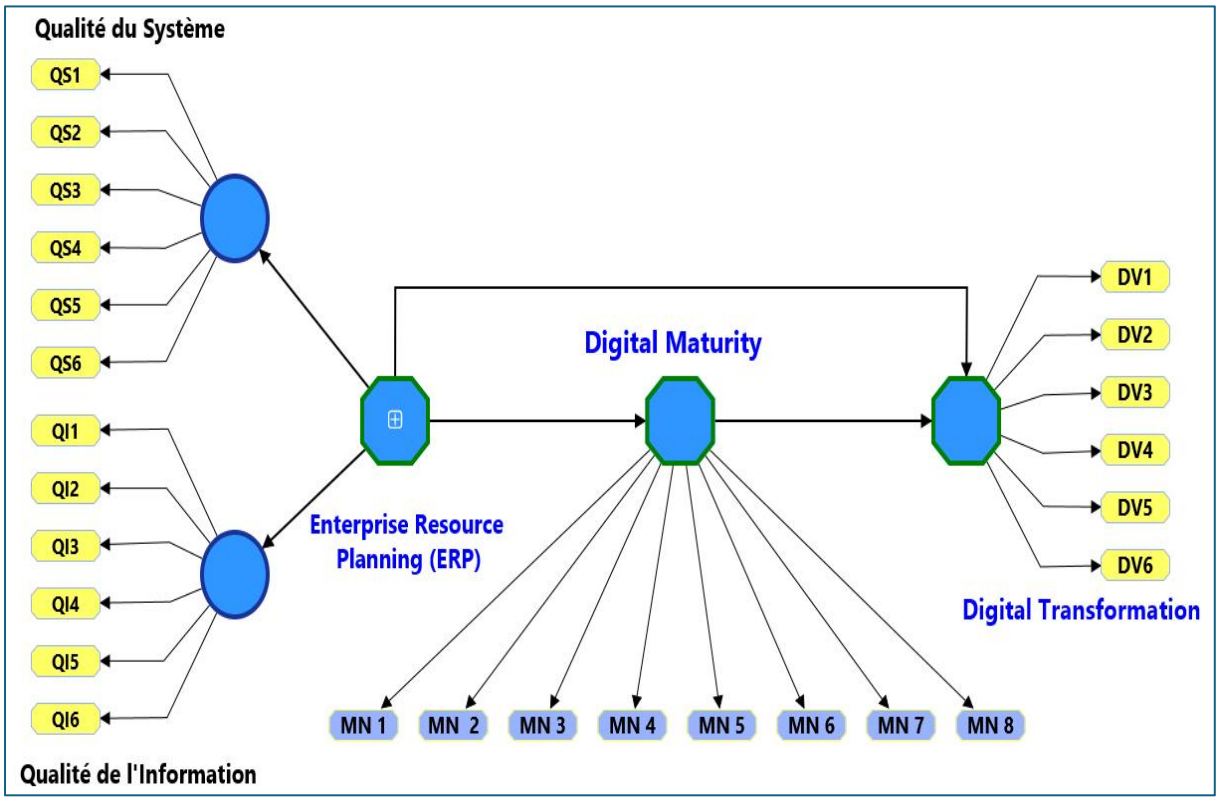
The measurement model represents the first stage in PLS- SEM before proceeding to the evaluation of the structural model and the testing of hypotheses (second stage). There are several statistical criteria and indicators used to assess measurement models within the SEM- PLS framework, which are provided by the SmartPLS 4 program and are presented in the following table.

Table 11 : Criteria for evaluating the reflective measurement model under the SEM-PLS methodology

Assessment Types	Evaluation criterion	Adopted evaluation rule and threshold	Reference
1	**Indicator reliability**	The outer loadings of the indicators should be higher than 0.708. Indicators with loadings between 0.40 and 0.70 should only be deleted if their removal leads to an increase in composite reliability or in the average variance extracted (AVE).	(pp.116–117)
2	**Internal consistency reliability**	Assessed using three indicators: (1) Cronbach's alpha, (2) composite reliability rho_c, and (3) reliability coefficient rho_A. Values should fall between 0.70 and 0.95. Values between 0.60 and 0.70 are acceptable in exploratory research, whereas values above 0.95 are undesirable because they indicate redundancy among the items.	(pp.118–119)
3	**Convergent validity**	Assessed using the average variance extracted (AVE). The AVE value should be higher than 0.50, which means that the construct explains more than half of the variance of its indicators.	(p. 120)
4	**Discriminant validity**	Assessed primarily using the HTMT criterion. The HTMT value should be less than 0.90 for conceptually similar constructs (or less than 0.85 for conceptually distinct constructs). In addition, the confidence interval of the HTMT estimate must not include the value 1.	(pp.122–124)

Source: Prepared by the student based on(Hair et al., 2022)

Figure 3 : The measurement and structural model estimated using SmartPLS 4



Source: Output generated by SmartPLS v4

3.2.1.1 Assessing indicator reliability

Indicator reliability represents the first step in evaluating the measurement model and aims to ensure that each item (indicator) effectively and strongly contributes to measuring the construct to which it belongs. A high outer loading for an item indicates a strong association between that item and the underlying construct it measures, which means that the item provides an accurate and valid representation of the construct.

The outer loading value for each indicator should be greater than 0.70, as this threshold ensures that the construct explains more than half of the variance in that item, thereby providing high confidence that the measurement instrument (questionnaire) actually captures what it was designed to measure. However, indicators with loadings below 0.70 should not be removed automatically; instead, the following analytical logic is recommended, in line with (Hair et al., 2022, pp. 118–119)

- Indicators with **loadings lower than 0.40** must be removed.
- For indicators with **loadings between 0.40 and 0.70**, the decision to delete them is made only if their removal leads to an increase in the Average Variance Extracted (AVE) beyond the acceptable threshold of 0.50. If the model already satisfies this AVE criterion, such indicators are retained in order to preserve construct coverage and maintain content validity.
- Indicators with **loadings of 0.70 or higher** are retained.

The following table presents the results of the outer loadings for all study indicators and the corresponding AVE values:

Table 12 : Results of indicator reliability assessment

Variables		Indicators	Results of Indicators Evaluation Criteria			After Model Adjustment	
			Initial Outer Loadings	Values AVE	Decision (Retained/Deleted)	Final Outer loading	AVE
Enterprise Resource Planning (ERP)	System Quality	QS1	0,527	**0.457**	**Deleted**	**Deleted**	**0.509**
		QS2	0,654		**Retained**	0.560	
		QS3	0,754		**Retained**	0.753	
		QS4	0,734		**Retained**	0.756	
		QS5	0,706		**Retained**	0.773	
		QS6	0,655		**Retained**	0.702	
	Information Quality	QI1	0,759	**0.477**	**Retained**	0.748	**0.547**
		QI2	0,686		**Retained**	0.729	
		QI3	0,723		**Retained**	0.774	
		QI4	0,815		**Retained**	0.830	
		QI5	0,647		**Retained**	0.596	
		QI6	0,462		**Deleted**	**Deleted**	
Digital Maturity		MN 1	0,706	**0.391**	**Retained**	0.746	**0.527**
		MN 2	0,681		**Retained**	0.773	
		MN 3	0,720		**Retained**	0.753	
		MN 4	0,615		**Retained**	0.628	
		MN 5	0,555		**Deleted**	**Deleted**	
		MN 6	0,323		**Deleted**	**Deleted**	
		MN 7	0,717		**Retained**	0.721	
		MN 8	0,587		**Deleted**	**Deleted**	
Digital Transformation		DV1	0,806	**0.565**	**Retained**	0.812	**0.564**
		DV2	0,769		**Retained**	0.779	
		DV3	0,813		**Retained**	0.812	
		DV4	0,720		**Retained**	0.713	
		DV5	0,669		**Retained**	0.658	
		DV6	0,725		**Retained**	0.721	

Source: Prepared by the student based on the outputs of SmartPLS 4.

The table above presents the results of the indicator reliability assessment by examining the outer loadings and the Average Variance Extracted (AVE). The model was subjected to a

refinement process in order to ensure that the first step assessing indicator reliability meets the required conditions. The main results can be summarized as follows:

1.Deletion of weak indicators: The indicator MN6 was removed necessarily, due to its low outer loading (0.323, which is below the minimum threshold of 0.40), indicating a weak association with the digital maturity construct.

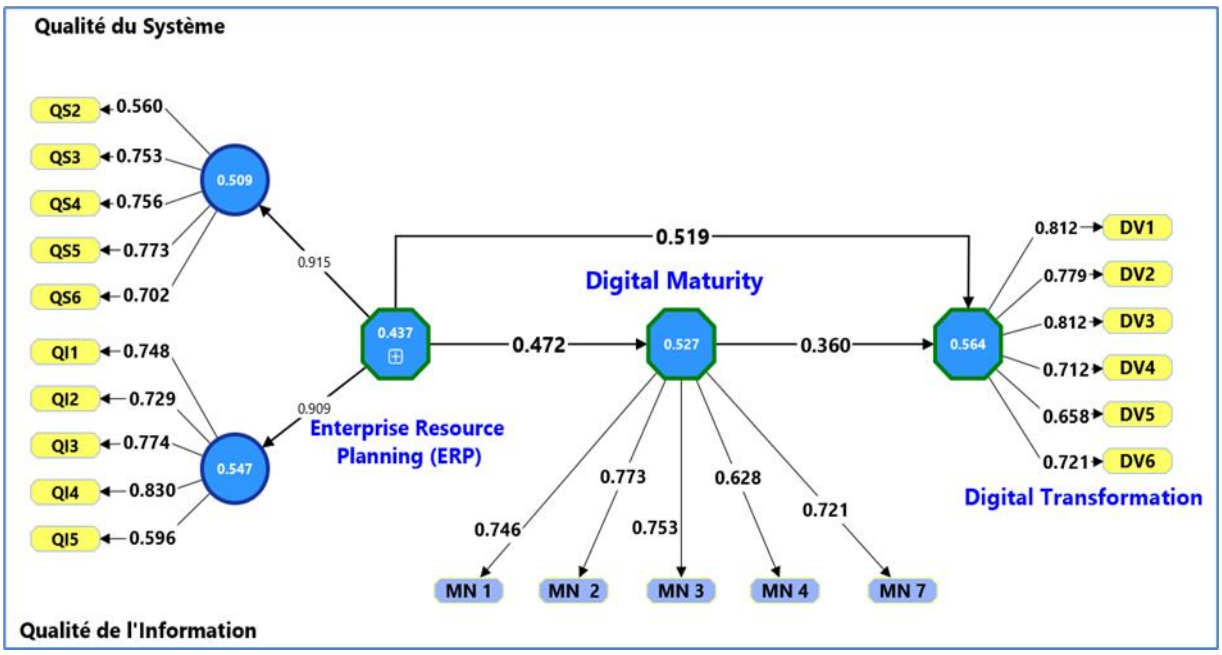
2. To improve the quality of the model and satisfy the condition AVE > 0.50, the indicators QS1, QI6, MN5, and MN8 were deleted. Although their outer loadings fell within the moderate range (0.40–0.70), their removal was necessary in order to raise the AVE values to the acceptable threshold of 0.50.

3. The post- refinement results can be summarized as follows:

- **ERP system dimensions:** After removing the weak indicators, the AVE for the system quality dimension increased from 0.457 to 0.509, and for the information quality dimension from 0.477 to 0.547, with strong outer loadings ranging between 0.560 and 0.830.
- **Digital maturity construct:** Following the adjustments, the AVE value rose from 0.391 to **0.527**, confirming that the remaining indicators (MN1, MN2, MN3, MN4, MN7) validly represent the conceptual domain of digital maturity.
- **Digital transformation construct:** This construct maintained its stability and high reliability from the outset, with an AVE of **0.564** and consistently high outer loadings, all exceeding 0.65.

Accordingly, and based on the outputs reported in the "after model refinement" column of the preceding table, it can be concluded that all remaining indicators in the model now exhibit high reliability, and all constructs meet the convergent validity criterion (AVE > 0.50). This allows us to proceed to the next step, namely the assessment of the internal consistency reliability of the scale.

Figure 4 :The measurement and structural model after refinemen



Source: Output generated by SmartPLS v4.

3.2.1.2 2. Assessing internal consistency reliability

After verifying indicator reliability and convergent validity, the next step is to assess the internal consistency of the constructs in the measurement model. This is done using three complementary criteria, each with its own properties and threshold values, which together provide a comprehensive and robust evaluation of the measurement model.(Hair et al., 2022, pp. 118–119)

a. **Cronbach's alpha (α)**

Cronbach's alpha is the traditional and most widely used coefficient for assessing internal consistency. However, it should be interpreted as a conservative measure because of several limitations. It assumes that all indicators have equal reliability (that is, equal outer loadings on the latent variable), an assumption that is rarely met in practice. In addition, PLS- SEM prioritizes indicators according to their individual reliability rather than assuming equality. Cronbach's alpha is also sensitive to the number of items in the scale and generally tends to underestimate the true level of internal consistency reliability, which makes it a cautious, lower- bound estimate.

b. **Composite reliability (CR or rho_c)**

To overcome the limitations of Cronbach's alpha, composite reliability is considered technically more appropriate in the context of PLS- SEM. This coefficient takes into account the different outer loadings of the indicators, and therefore better reflects the actual contribution of each item to measuring the construct. Composite reliability values range from 0 to 1, with higher values indicating higher reliability. However, while Cronbach's alpha

tends to underestimate internal consistency, composite reliability sometimes tends to overestimate it, which may result in relatively higher reliability estimates.

c. **Reliability coefficient (rho_A)**

Since Cronbach's alpha may underestimate the true reliability and composite reliability may overestimate it, it is recommended to include a third criterion for assessing internal consistency: the reliability coefficient rho_A. This coefficient is considered a more accurate estimate of reliability, and its values typically lie between those of Cronbach's alpha and composite reliability (CR). For this reason, rho_A is viewed as a balanced and dependable indicator that can be relied upon for the final judgment on the degree of internal consistency of the latent variables in the model.
The values of these three criteria must be greater than 0.70 to indicate an acceptable level of internal consistency. The following table reports the values of these criteria for the constructs of the study:

Table 13 : Results of internal consistency and reliability assessment

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
System Quality	0.755	0.766	0.836
Information Quality	0.788	0.795	0.857
Enterprise Resource Planning (ERP)	0.855	0.859	0.885
Digital Maturity	0.776	0.783	0.847
Digital Transformation	0.846	0.858	0.885

Source: Output generated by SmartPLS v4.

From examining the statistical results in the table above, the following points can be highlighted:

1.All values of the three criteria (Cronbach's alpha, rho_A, and composite reliability rho_c) for all study variables and their dimensions clearly exceed the minimum threshold of 0.70 and remain below the upper limit of 0.95. This indicates that the items are free from excessive redundancy or overlap.

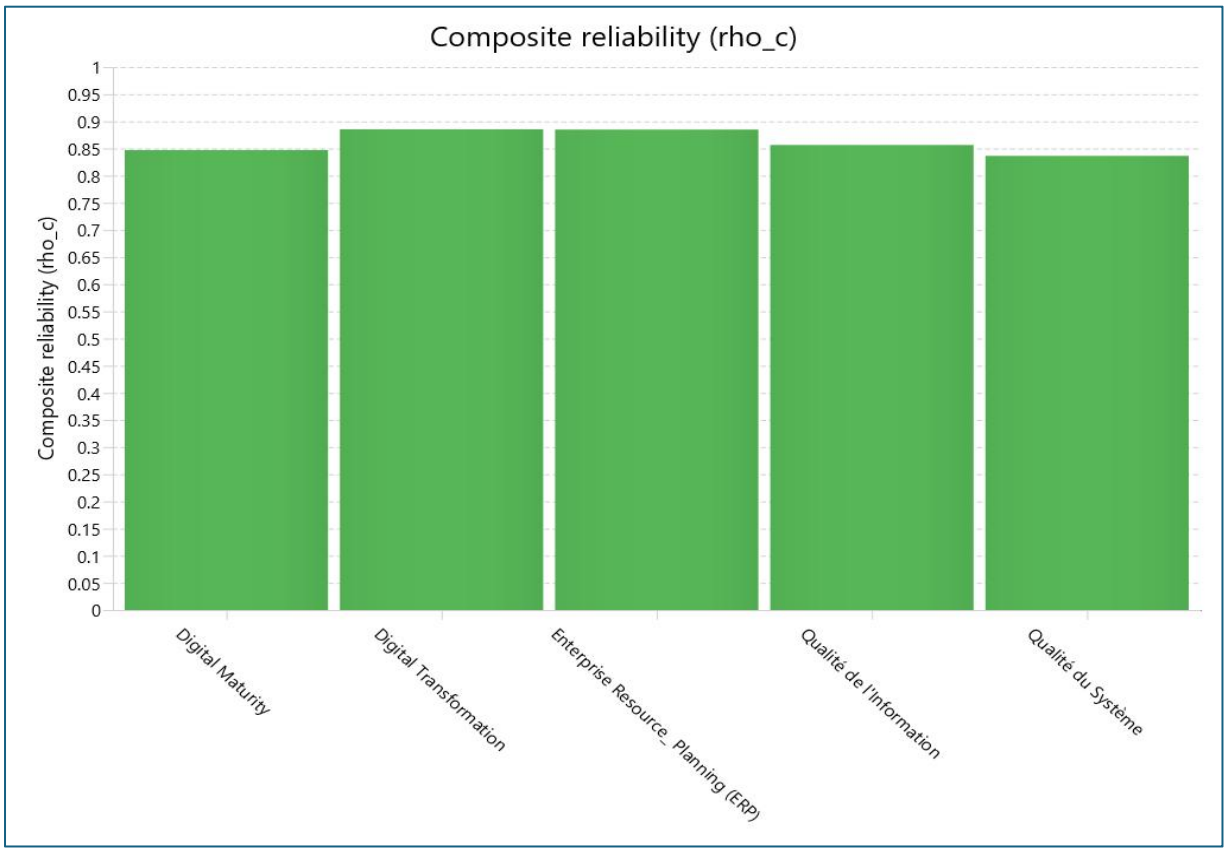
2. It is also observed that Cronbach's alpha values are always the lowest (as a conservative measure), whereas composite reliability (rho_c) yields the highest values, and the rho_A coefficient consistently falls between them for all constructs.

3.The main constructs (ERP system, digital maturity, and digital transformation) show particularly high levels of composite reliability, with values of 0.885, 0.847, and 0.885 respectively. This provides strong evidence of the reliability of the measurement model and

the stability of its results, suggesting that similar findings would likely be obtained if the study were replicated under the same conditions.

General conclusion: Based on these positive indicators, it can be confirmed that the measurement model exhibits **very high internal consistency and reliability**, which implies that respondents' answers were stable and consistent and would remain so if the study were repeated in the same context. These results make it possible to move on to the next step, namely the assessment of convergent and discriminant validity of the model.

Figure 5 :Composite reliability (rho_c) values for the study constructs



Source: Output generated by SmartPLS v4.

3.2.1.3 Discriminant validity:

Discriminant validity aims to verify that each construct in the model represents a distinct and independent concept from the other constructs and that it does not measure the same underlying concept as another variable. In this study, discriminant validity was assessed using the Heterotrait–Monotrait Ratio (HTMT) criterion

To conclude that discriminant validity is established based on this criterion, the HTMT value between any two constructs must be less than the threshold of 0.90(J. F. Hair et al., 2022, p. 122). The following table reports the HTMT values obtained for the study variables.

Table 14 :Discriminant validity assessment results using the HTMT criterion

Heterotrait-monotrait ratio (HTMT) - Matrix	Digital Maturity	Digital Transformation	Enterprise Resource_ Planning (ERP)	Information Quality	System Quality
Digital Maturity					
Digital Transformation	0,726				
Enterprise Resource Planning (ERP)	0,562	0,793			
Information Quality	0,439	0,677	0,857		
System Quality	0,643	0,848	0,877	0,853	

Source: Prepared by the student based on the outputs of SmartPLS v4.

The table above presents the HTMT matrix of discriminant validity results for all constructs. By examining the values reported in the matrix, the following observations can be made:

1. The HTMT values between all pairs of constructs are below the maximum threshold of 0.90, with the observed values ranging from 0.439 as the lowest to 0.877 as the highest.
2. These results indicate that each construct in the model represents a distinct concept and that there is no overlap or redundancy between the variables used. For example, the HTMT value between digital maturity and digital transformation is 0.726, which confirms that the two constructs are empirically distinct.
3. **Summary of measurement model assessment (Measurement Model):** Based on the results obtained across all stages of the measurement model evaluation, which included:

   - Confirming indicator reliability (outer loadings)
   - Demonstrating internal consistency and reliability (Cronbach's alpha and composite reliability)
   - Verifying convergent validity (AVE)
   - Ensuring discriminant validity (HTMT)

We conclude that the measurement model of the study enjoys a high level of validity and reliability, which means that the respondents' answers were stable and consistent and would remain so if the study were replicated under the same conditions. These results allow us to move on to the second stage, namely **the evaluation of the structural model (Structural Model) and the testing of the study hypotheses.**

3.2.2 Structural model assessment and hypothesis testing

After confirming the quality and validity of the measurement model in the previous stage, we now move to the second stage, which is the evaluation of the structural model and the testing of the study hypotheses. This evaluation aims to examine the impact relationships between the variables in the Sonatrach company (Hassi R'Mel Directorate) under study, through the estimation of path coefficients that represent the proposed hypotheses and by determining the extent to which the field data support the theoretical framework of the study. The assessment and hypothesis testing process is carried out according to the following criteria and steps:

Table 15 :Criteria for assessing the structural model under the SEM- PLS methodology

Step	Assessment Criterion	Description	Threshold	Reference(Hair et al., 2022)
1	Collinearity Assessment (VIF)	Assessing the absence of high correlations between predictors.	VIF < 3: No collinearity. 3 ≤ VIF ≤ 5: Potential collinearity. VIF > 5: Critical collinearity.	p. 191
2	Coefficient of Determination (R^2)	Measuring the proportion of variance explained in dependent variables.	$R^2 \geq 0.67$: Substantial. $0.33 \leq R^2 < 0.67$: Moderate. $0.19 \leq R^2 < 0.33$: Weak.	(Chin, 1998)
3	Predictive Relevance (Q^2)	Assessing the model's ability to predict future data (Q^2 predict).	$Q^2 \geq 0$: Indicates good predictive relevance.	p. 197
4	Effect Size (f^2)	Measuring the individual contribution of a predictor variable.	$0.02 \leq f^2 < 0.15$: Small. $0.15 \leq f^2 < 0.35$: Medium. $f^2 \geq 0.35$: Large.	pp. 195–196
5	Path Coefficients	Determining the statistical significance of hypothesized paths.	P-value ≤ 0.05 (Significant). Larger β values indicate stronger paths.	pp. 192–194
6	Mediation Analysis	Examining the mediating role and the nature of the indirect effect.	Significant indirect effect ($p < 0.05$). Full mediation vs. Partial mediation.	pp. 232–244
7	Analyzing the mediation effect magnitude and type.			

Source: Prepared by the student based on (Hair et al., 2022)

3.2.2.1 Assessing multicollinearity among the predictor constructs in the structural model

As a first step in evaluating the structural model, it is necessary to examine each set of predictor variables (constructs that are used to predict a dependent construct) in order to ensure the absence of multicollinearity problems. If there are high correlation levels among the predictor constructs, the estimates of the path coefficients become biased, which reduces the reliability of the results and affects their interpretation. In this study, we rely on the Variance Inflation Factor (VIF) for each predictor construct. The VIF values can be interpreted according to the following levels(J. F. Hair et al., 2022, p. 191):

- VIF < 3 (less than 3): Indicates no multicollinearity problem (ideal level).
- 3 ≤ VIF ≤ 5: Indicates potential but acceptable multicollinearity (at this level, it is not necessarily a serious issue).
- VIF > 5 (greater than 5): Indicates a critical multicollinearity problem that requires corrective action.

The following table presents the results of this assessment.

Table 16 : Results of multicollinearity assessment using the VIF coefficient

Relationships between constructs	Variance Inflation Factor (VIF)	Result
ERP system → Digital maturity	1.000	No multicollinearity problem between the constructs

ERP system → Digital transformation	1.287	No multicollinearity problem between the constructs
Digital maturity → Digital transformation	1.287	No multicollinearity problem between the constructs

Source: Prepared by the student based on the outputs of SmartPLS 4.

The results in the table show that all VIF values for the relationships between the constructs are lower than the critical value of 3. This confirms that there is no multicollinearity problem between the variables in the model, which ensures the accuracy and reliability of the estimated path coefficients. Accordingly, the statistical conditions are met to proceed to the next step, namely testing the significance of the path coefficients (direct and indirect hypotheses).

3.2.2.2 Assessment of the coefficient of determination (R^2) between the constructs in the structural model:

The coefficient of determination (R^2) is one of the most important criteria for evaluating the structural model, as it measures the predictive accuracy of the model by indicating the proportion of variance in the endogenous constructs that is explained by the exogenous construct(s). R^2 values are typically interpreted as strong, moderate, or weak. Chin (1998) proposed specific thresholds for interpreting R^2 values as follows(Chin, 1998, p. 323):

- $R^2 \geq 0.67$: considered strong
- $0.33 \leq R^2 < 0.67$: considered moderate
- $0.19 \leq R^2 < 0.33$: considered weak

It should be noted that Chin did not specify a threshold for values below 0.19, but in empirical research practice, R^2 values lower than 0.19 are often regarded as unacceptable or as having very low explanatory power.

The following table presents the R^2 results obtained for the constructs in the study model.

Table 17 : Results of the R^2 assessment for the structural model

Effect path (relationship)	Endogenous construct (predicted)	R^2	Effect level (Cohen)
ERP system → Digital maturity	Digital maturity	0.223	Weak (acceptable)
ERP system → Digital transformation	Digital transformation	0.576	Moderate to strong
Digital Maturity → Digital transformation		0.576	Moderate to strong

Source: Prepared by the student based on the outputs of SmartPLS 4.

The outputs of the table above show a variation in the predictive power of the model depending on the constructs, as follows:

- **The mediating variable (digital maturity):** It recorded an R^2 value of 0.223, which means that the ERP system alone explains 22.3% of the variance in the level of digital maturity. Although this value is classified as "weak" according to Chin's criterion, it remains statistically acceptable since it exceeds the 0.19 threshold in the model; it

confirms that the adoption of the ERP system at Sonatrach effectively contributes to laying the groundwork for digital maturity.

- **The main dependent variable (digital transformation):** It achieved an R^2 value of 0.576, which falls within the moderate-to-strong range. This means that the two variables (ERP system and digital maturity) together explain 57.6% of the variance in digital transformation in the organization.
- **Integration of variables and the added value of mediation:** A clear **increase in explanatory** power is observed from **0.223** for digital maturity to **0.576** for digital transformation. This substantial increase **(a difference of 35.3%)** reflects the important role played by digital maturity as a mediating variable; moving from the mere presence of a "technical system" (ERP) to a "comprehensive digital transformation" necessarily requires a certain level of "digital maturity" to maximize the impact.

Conclusion: These results confirm that the model does not rely on technology alone; rather, it highlights the **methodological integration** between system efficiency (ERP) and organizational readiness (maturity) in achieving digital transformation. The higher the organization's digital maturity, the greater the ability of the ERP system to generate more precise and visible digital transformation outcomes, which explains the high explanatory power of the dependent variable in the model.

3.2.2.3 Regarding the predictive relevance of the model (Q^2):

In the previous step, we examined the explanatory power of the model by evaluating the size of the R^2 values. In this step, we assess its predictive relevance using the Q^2 indicator.

Q^2 threshold:

- **$Q^2 > 0$:** If the value is greater than zero, this indicates that the model has predictive relevance for the endogenous variable concerned.
- **$Q^2 \leq 0$:** If the value is zero or less, this means that the model lacks predictive relevance for that variable.(Hair et al., 2020, p. 267)

Table 18 : Results of predictive relevance (Q^2) assessment for the model

Endogenous construct	Q^2_predict	Predictive relevance	Threshold
Digital Maturity	0.183	Good predictive relevance	$Q^2 > 0$
Digital transformation	0.448	Good predictive relevance	$Q^2 > 0$

Source: Prepared by the student based on the outputs of SmartPLS.

The outputs in the table show that all Q^2_predict values for the endogenous and mediating variables are positive and relatively high, and their implications can be summarized as follows:

- The mediating variable (digital maturity): It recorded a value of 0.183, which is positive and greater than zero. This confirms the ability of the ERP system to predict the levels of digital maturity in the organization under study.
- The dependent variable (digital transformation): It achieved a high predictive value of 0.448. This result is a strong indication of the quality of the structural model, as the

data show that the interaction between the ERP system and digital maturity provides a high predictive ability regarding the paths of digital transformation in Sonatrach with considerable accuracy.

Conclusion: The Q^2_predict results confirm that the structural model does not only possess explanatory power (R^2), but also exhibits good predictive relevance. This statistical robustness lends strong credibility to the findings and allows moving on to the next step, namely the assessment of effect size (f^2) and then the testing of the significance of the path coefficients (hypotheses).

3.2.2.4 Assessment of effect size (f^2) under the SEM- PLS approach:

In addition to evaluating the R^2 values of the endogenous variables in the structural model, the change in R^2 when a specific exogenous variable is removed from the model can be used to assess whether the removed variable has a substantive impact on the endogenous construct. This provides a clear view of the relative importance of each predictor. This measure is referred to as the effect size (f^2), where higher f^2 values indicate a greater impact. According to(Cohen, 1988, p. 410), the values are classified as follows:

- $0.02 \leq f^2 < 0.15$: small effect
- $0.15 \leq f^2 < 0.35$: medium effect
- $f^2 \geq 0.35$: large effect

In the context of the current study model, the effect size (f^2) was calculated and evaluated for each direct relationship in the structural model, and the following table presents the results obtained.

Table 19 : Results of effect size (f^2) assessment for the relationships in the structural model

Effect path (relationship)	Endogenous construct (predicted)	Effect size f^2	Effect level (Cohen)
ERP system → Digital maturity	Digital maturity	0.287	Medium
ERP system → Digital transformation	Digital transformation	0.493	Large
Digital maturity → Digital transformation	Digital transformation	0.238	Medium

Source: Prepared by the student based on the outputs of SmartPLS.

The results in the table above show variation in the effect size levels exerted by the explanatory variables, as follows:

- **Effect of the ERP system on digital transformation**: It recorded the highest effect size value of **0.493**, which exceeds the threshold of **0.35**. This means that the ERP system has a **large impact** on achieving digital transformation at Sonatrach, reflecting the strategic importance of the system as a main driving force.
- **Effect of the ERP system on digital maturity**: It achieved an effect size of **0.287**, which falls within the **medium** range. This result indicates that the efficiency of the

system contributes in an effective and clear way to strengthening the organization's digital maturity.

- **Effect of digital maturity on digital transformation**: It recorded an effect size of **0.238**, which is a **medium** effect. This confirms that the presence of certain levels of digital maturity among individuals and within the organization makes a real contribution to achieving comprehensive digital transformation.

Conclusion: The f^2 effect size results show that all structural paths proposed in the model have statistically meaningful importance, providing evidence of the robustness of the theoretical structure of the proposed model. The findings not only confirm the statistical relevance of each individual path, but also highlight the key role of the ERP system and the significant contribution of the mediating variable (digital maturity) as a complementary factor in achieving digital transformation at Sonatrach. Since all predictor variables exceed the acceptable effect size thresholds and fall within the medium-to-large range, it is confirmed that the adopted model has high capability in representing the phenomenon under study, which allows moving on to the next step: testing the significance of the path coefficients and verifying the validity of the study hypotheses.

3.2.2.5 Assessment of the statistical significance of the path coefficients in the structural model and hypothesis testing

After verifying the quality of the structural model using the indicators VIF, R^2, Q^2, and f^2, we proceed to test the hypotheses by estimating the path coefficients. To judge the significance of these relationships, the Bootstrapping technique was applied in SmartPLS 4 to obtain the following indicators:

- **Path coefficient (β):** Measures the strength and direction of the relationship (between −1 and +1); values close to one indicate a strong relationship.
- **T-statistic**: Must exceed the critical value of 1.96 at the 0.05 significance level in order to consider the effect significant.
- **P-value**: The most precise criterion of statistical significance; it must be less than 0.05 to reject the null hypothesis.
- **Confidence intervals**: To confirm the existence of a real effect, the 95% confidence interval must not include the value zero.

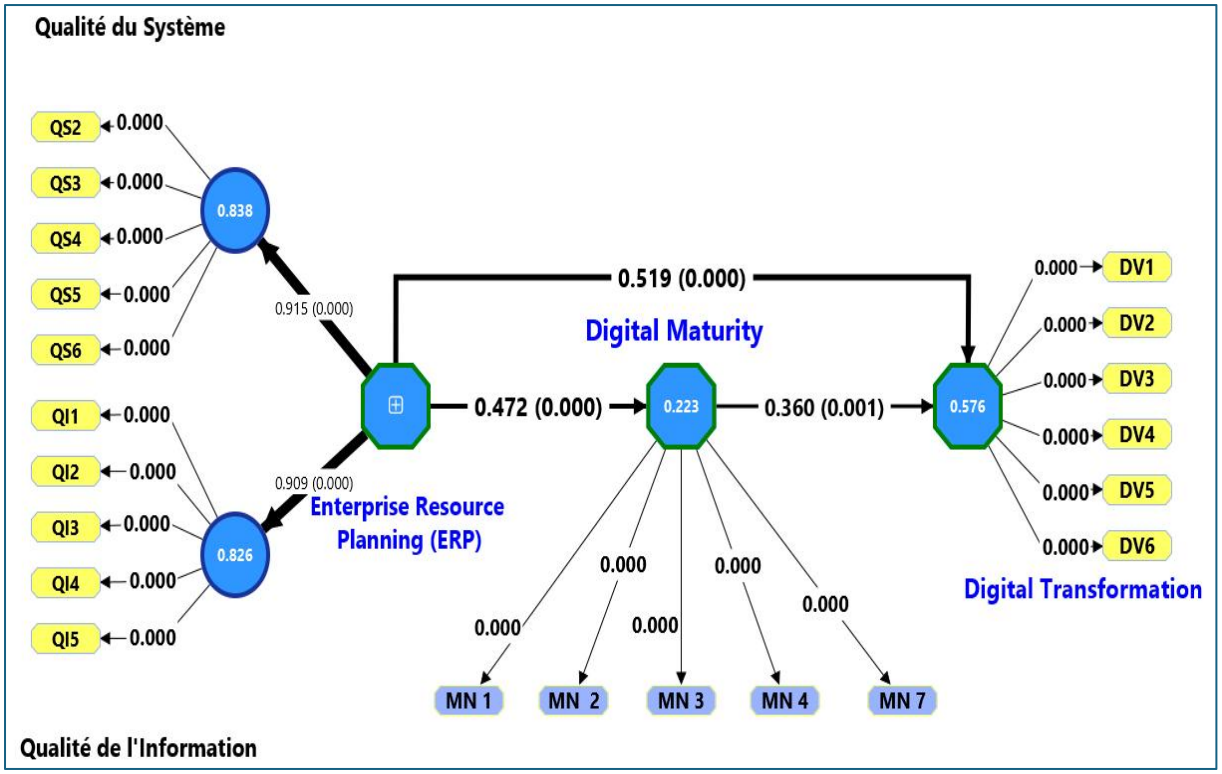
Statistical decision rule for hypothesis testing (H0 and H1) is based on these criteria.

Statistical Criterion	State: Accept Alternative Hypothesis (H_1)	State: Reject Alternative Hypothesis (H_1)
P-value	$P < 0.05$	$P > 0.05$
T-statistic	$T > 1.96$	$T < 1.96$
Confidence Interval	Does not include zero	Includes zero
Statistical Decision	Statistically significant (Accept H_1)	Not statistically significant (Reject H_1)

The hypotheses that the present study seeks to test are as follows:

- Hypothesis 1 (H1): Enterprise Resource Planning (ERP) systems have a positive and significant effect on digital transformation **at Sonatrach (Hassi R'Mel Directorate).**
- Hypothesis 2 (H2): Enterprise Resource Planning (ERP) systems have a positive and significant effect on digital maturity at **Sonatrach (Hassi R'Mel Directorate).**
- Hypothesis 3 (H3): Digital maturity has a positive and significant effect on digital transformation at **Sonatrach (Hassi R'Mel Directorate).**
- Hypothesis 4 (H4): Digital maturity plays a mediating role in the relationship between ERP systems and digital transformation at **Sonatrach (Hassi R'Mel Directorate).**

Figure 6 :Estimated path coefficients for the structural model relationships between the study variables



Source: Output generated by SmartPLS v4.

Table 20 : Results of testing direct and indirect effect hypotheses in the structural model

Type of effect	Path (hypothesis)	Path coefficient (β)	T-value	P-value	95% confidence interval	Statistical decision
Direct	H1: ERP system → Digital transformation	0.519	5.379	0.000	[0.313, 0.687]	Accepted
Direct	H2: ERP system → Digital maturity	0.472	4.829	0.000	[0.285, 0.667]	Accepted
Direct	H3: Digital maturity →	0.360	3.444	0.001	[0.172, 0.577]	Accepted

	Digital transformation					
Indirect	H4: ERP system → Digital maturity → Digital transformation	0.170	2.410	0.016	[0.069, 0.341]	Accepted

Source: Prepared by the student based on the outputs of SmartPLS.

3.2.2.5.1 Analysis of the direct effects and testing hypotheses (H1, H2, H3)

1.Testing the first hypothesis (H1): The results indicate a positive and statistically significant effect of the ERP system on digital transformation at Sonatrach. The path coefficient is **0.519**, with a T-value of **5.379**, which is greater than 1.96, and a significance level of **P = 0.000**, which is lower than **0.05**. In addition, the 95% confidence interval does not include zero, which leads to the **acceptance of the first hypothesis**.

2.Testing the second hypothesis (H2): The findings show that the ERP system has a positive and significant effect on digital maturity, with a path coefficient of **0.472**, a T-value of **4.829**, and a significance level of **P = 0.000**. Accordingly, the **second hypothesis is accepted**, confirming the role of the system in enhancing the organization's digital readiness.

3.Testing the third hypothesis (H3): The results reveal a positive and significant effect of digital maturity on digital transformation, with a path coefficient of **0.360**, a T-value of **3.444**, and a significance level of **P = 0.001**. This result supports the **acceptance of the third hypothesis**, demonstrating that organizational readiness (maturity) is a key driver of successful digital transformation.

3.2.2.5.2 Analysis of the mediation effect and testing hypothesis H4

To achieve the study's objective of examining the mediating role of digital maturity, the specific indirect effect of the ERP system on digital transformation through digital maturity was analyzed, and the results were as follows:

- **Results of the indirect effect**: The value of the indirect effect was **0.170**, with a T-value of **2.410**, which is greater than 1.96, and a significance level of **P = 0.016**, which is lower than 0.05. It is also noted that the 95% confidence interval [0.069, 0.341] does not include zero.
- **Determining the type of mediation**: Since the indirect effect is statistically significant, and the direct effect of the ERP system on digital transformation also remains statistically significant (based on the H1 results), we conclude that there is **partial mediation**.

Statistical decision: Based on the above, hypothesis H4 is accepted, which means that digital maturity effectively helps to transmit and reinforce part of the effect of the ERP system in enhancing the efficiency of digital transformation processes at Sonatrach.

4 FOURTH: Discussion of Results and Conclusions

After presenting and statistically analyzing the data and testing the hypotheses in the previous section, this section moves to the stage of discussing the findings. Having established through statistical analysis that ERP systems have an effect on digital transformation, and that this effect operates through both a direct path and an indirect path via digital maturity, we now discuss these results to provide a deeper understanding of their implications in the context of Sonatrach.

The empirical results will be linked to the theoretical framework and to previous studies, and each hypothesis will be addressed to clarify the extent of its support and to compare it with the conclusions of related prior research. This will highlight the scientific contribution of the present study in explaining the mechanism of digital transformation at the Hassi R'Mel Directorate.

4.1 Discussion of the direct effect hypotheses

First: Discussion of the first hypothesis result (direct effect of the ERP system on digital transformation)

- ✓ The modeling results show a strong positive and significant effect of the ERP system on digital transformation at Sonatrach ($\beta=0.519, P=0.000$), indicating that a higher level of adoption and use of the ERP system within the company is associated with a noticeable increase in the level of digital transformation. This relationship was reflected in the field observations through the gradual shift from paper-based and fragmented processing of operations to integrated digital processing via the SAP platform, whether in terms of information flow between departments, the automation of many routine procedures, or the availability of real-time data to decision-makers, which enhances responsiveness and the accuracy of operational monitoring. The researcher also observed an improvement in the level of transparency and the ability to track various operations (such as purchase orders and inventory movements), which confirms the pivotal role of the ERP system in providing a technical and organizational foundation that supports digital transformation initiatives within Sonatrach.
- ✓ This result is consistent with the findings of Kerbache Rahma (2024), who highlighted that the SAP S/4HANA platform enables organizations to advance their digital transformation by integrating processes and data into a unified system with advanced analytical capabilities. It also aligns with the results of the study by Khawla Adnani and Abdeldjalil Mokedem (2025), which demonstrated the positive impact of adopting ERP systems on improving operational performance at Sonatrach, including the efficiency of the supply chain and the effectiveness of information flows. Furthermore, it supports the view of Annika Nordlund (2023), who considered the ERP system to be the "backbone" of digital transformation projects, as it provides a central platform for data and process integration on which other advanced digital technologies within the organization can be built.

Second: Discussion of the second hypothesis result (effect of the ERP system on digital maturity)

- ✓ The modeling results show that the second hypothesis is supported, as the ERP system has a positive and significant effect on digital maturity, with a path coefficient of β=0.472\beta = 0.472β=0.472 at a significance level of P=0.000P = 0.000P=0.000. This indicates that higher levels of ERP adoption and use within Sonatrach are associated with a transition to higher levels of digital maturity, and that the SAP system contributes to consolidating more mature digital practices by improving data integration, standardizing information flows, and regularly relying on digital indicators in management, all of which reflect the development of the company's digital readiness.
- ✓ This result is consistent with the findings of Deniz Merdin et al. (2023), who emphasized that technology and data management are core dimensions of digital maturity and that reaching advanced levels of maturity requires using these tools to systematically structure processes and support decision-making. In this context, Sonatrach's investment in the SAP system can be considered a key factor in building the company's digital infrastructure and enhancing its digital maturity level by developing its technical and organizational capabilities in managing data and processes in a more professional manner.

Third: Discussion of the third hypothesis result (effect of digital maturity on digital transformation)

- ✓ The results show that the third hypothesis is supported, as digital maturity has a positive and significant effect on digital transformation, with a path coefficient of β=0.360\beta = 0.360β=0.360 at a significance level of P=0.001P = 0.001P=0.001. This confirms that digital transformation is not a purely technical process, but fundamentally depends on the organization's level of digital maturity, in terms of its capabilities, structures and readiness to effectively use digital technologies.
- ✓ This result is consistent with the study by Mina Nasiri et al. (2022), which emphasized that digital maturity is a key determinant of success in digital transformation settings. It also converges with the findings of Amani Salma Belhaouari (2024), who showed that the effectiveness of digital transformation increases when there is organizational awareness and readiness to work with integrated systems, indicating that higher levels of digital maturity provide a more favorable environment for achieving successful and sustainable digital transformation.

4.2 Discussion of the mediation hypothesis (H4)

Analysis of the mediating role of digital maturity

- ✓ The fourth hypothesis posited a mediating role for digital maturity, and the results showed a significant indirect effect (β = 0.170, P = 0.016).

- ✓ **Determining the type of mediation:** Given that both the direct and indirect effects are statistically significant, **the mediation is classified as partial**. This means that the ERP system affects digital transformation at Sonatrach through two paths: a direct technical path, and an indirect organizational path that operates via the development of digital maturity levels among employees and processes.
- ✓ **Comparison with previous studies:** This result is strongly in line with the study of Mina Nasiri et al. (2022), which statistically demonstrated that digital maturity plays a decisive mediating role in achieving success throughout the digital transformation

journey. It also complements the findings of Radouane Bouzoualegh (2020), who argued that ERP systems enhance competitive advantage but require a supportive organizational environment (maturity) to overcome cognitive and managerial challenges.

4.3 Scientific and practical contributions of the study

The results of this study provide an integrated view of the mechanism of digital transformation in large industrial energy enterprises. Its contribution can be summarized in two main dimensions:

First: Scientific contribution

1. **Building an integrated mediation model**: Unlike studies that focused on simple bilateral relationships, this study presented a model that tests **how** the effect occurs and not only **its existence**. By demonstrating the mediating role of digital maturity, the study supports the theoretical proposition of **Mina Nasiri et al. (2022)** that maturity is the main channel that maximizes the return on technological investments.
2. **Consolidating the role of digital maturity as a mediating variable**: The study contributes to establishing the concept of "digital maturity" as a connecting link between technology (ERP) and strategic outcomes (transformation). This is consistent with the model of **Deniz Merdin et al. (2023),** where our results showed that digital transformation at Sonatrach is not an automatic result of using the SAP system, but rather the result of the interaction of this system with the readiness of employees and processes (maturity).
3. **Enriching the literature on the energy sector**: The study provides a theoretical and practical reference on digital transformation in the hydrocarbons sector in Algeria, which is a sector characterized by high technical and organizational specificity, making our results an important addition for researchers interested in modeling digital transformation in complex industrial environments.

Second: Practical contribution

The study provides a set of contributions and lessons learned for the managers of Sonatrach (Hassi R'Mel Directorate) and the industrial sector in general:

1. **Overcoming the narrow technical view**: The results showed that the direct effect of the ERP system on digital transformation is strong ($\beta = 0.519$), but it remains incomplete without "digital maturity". This directs decision-makers at Sonatrach to the fact that investing in "human capital" and developing employees' digital culture is no less important than investing in updating **SAP software**.
2. **Importance of system and information quality**: The significant contribution of the "system quality" and "information quality" dimensions in the structural model confirms what **Kerbache Rahma (2024)** concluded; the accuracy of reports and the ease of interfaces in the **SAP** system at the Hassi R'Mel Directorate are what create the necessary "trust" for digital transformation. Accordingly, data quality must continue to be improved to ensure the accuracy of predictive outputs.
3. **A roadmap for sustainable transformation**: Through the "paperwork" gap that appeared in the descriptive analysis, the study contributes to drawing management's attention to the need for full integration between the system and field operations. Real

digital maturity requires the gradual abandonment of manual records in order to maximize the benefit from the speed of task exchange provided by the **ERP** system, which was recommended by **Amani Belhaouari (2024)** to achieve transparency and efficiency.

4. **Supporting a predictive orientation**: In line with the results of Khawla Adnani (2025) on supply chain performance, our study contributes to confirming that the **ERP** system at Sonatrach provides a huge database **(Big Data)** that can be exploited in the future in artificial intelligence techniques, provided that this is accompanied by organizational maturity that allows the absorption of these advanced technologies

Conclusion of the applied chapter:

This chapter addressed the applied aspect of the study, where the field data collected from a sample of 69 individuals from the managers and employees of Sonatrach (Hassi R'Mel Directorate) were presented and analyzed, with the aim of testing the study hypotheses and answering its main research question related to the role of the ERP system in enhancing digital transformation.

- The statistical analysis began with an assessment of the current state of the study variables. The descriptive results showed strong positive tendencies; both the "ERP system" and "digital transformation" received high (agree) evaluations, reflecting the efficiency of the SAP system in meeting functional needs and improving services in the company. "Digital maturity" also received a positive evaluation that reflects the organization's readiness for transformation. Despite this overall optimism, the descriptive analysis revealed the existence of a "transitional phase" in digital maturity, as there was a clear superiority in the availability of "infrastructure and networks", while the "complete shift away from manual records" still represents the main challenge for the company.
- As for the core of the analysis, represented in testing the hypotheses using structural equation modeling (SEM-PLS), the results led to the acceptance of all research hypotheses. It was demonstrated that the ERP system has a positive and statistically significant effect on both digital maturity and digital transformation. More importantly, the results confirmed the partial mediating role played by "digital maturity"; the effect of the ERP system does not stop at the purely technical aspect, but contributes fundamentally to building the organization's capabilities (maturity), which in turn strengthen and drive the path of comprehensive digital transformation.
- Thus, the empirical results of this chapter have provided an integrated answer to the study's research problem, not only by confirming the existence of the hypothesized relationships, but also by clarifying the dual mechanism through which the ERP system operates (a direct technical effect and an indirect organizational effect through digital maturity). These findings offer a solid foundation for building the general conclusion of the study and formulating strategic recommendations for the decision-makers at Sonatrach.

General conclusion of the study:

The study aimed to analyze the mechanism through which Enterprise Resource Planning (ERP) systems influence the achievement of digital transformation, while testing the mediating role of digital maturity in the context of Sonatrach. The study started from a fundamental research problem, namely understanding how technological investments (the SAP system) are translated into an actual and sustainable digital transformation. To answer this question, data were collected through a questionnaire distributed to a sample of 69 managers and employees at Sonatrach's Hassi R'Mel Directorate.

The methodological importance of the study lay in the use of an advanced statistical approach, namely Structural Equation Modeling (SEM-PLS), with the aim of going beyond merely describing relationships to testing an integrated causal model and examining direct and indirect effects simultaneously. Based on this analysis, we will, in what follows, review the main results reached, then identify the scientific and practical contributions of the study, present a set of recommendations, and finally propose future research avenues.

First: The main results of the study: This study presents important results that can be displayed on two levels:

1. **At the theoretical level:** The theory shows that the three variables are closely linked. The main results are:

✓ **The Role of ERP**: ERP systems are more than just tools. They are the foundation that connects data and operations, which helps the company start its digital journey.
✓ **Digital Maturity as a Bridge**: Technology alone is not enough for transformation. The company needs "Digital Maturity" (like culture and skills). This maturity helps the company use the ERP system in the best way.
✓ **Digital Transformation as the Result**: Real digital transformation happens when a good ERP system works together with high digital maturity. This moves the company from just using digital data to changing the whole way it works

2. **At the field level:** The statistical analysis of the data collected at Sonatrach's Hassi R'Mel Directorate led to the following results:

- The results showed a "**high**" evaluation of the ERP system and digital transformation, which reflects the efficiency of the SAP system in the company. However, the analysis revealed a "**maturity gap**" in the dimension related to moving away from manual records, indicating that the company is still in a transitional phase toward full digitization.
- The results confirmed the **acceptance of all the study hypotheses**, which provided empirical support for the proposed model:
  - **Acceptance of (H1):** The existence of a strong, positive, and direct effect of the ERP system on digital transformation.
  - **Acceptance of (H2 and H3):** The results showed that the stronger effect proceeds through two stages; the first is the development of digital maturity, and the second is the translation of this maturity into a tangible digital transformation.
  - **Acceptance of (H4):** Confirmation that "**digital maturity**" **mediates the relationship** between the ERP system and digital transformation, and the analysis

revealed that the indirect effect (through maturity) represents a central part of the total effect, which proves that the ability of the SAP system to achieve transformation increases as the organization's level of maturity rises.

Second: Contributions of the study

- **Theoretical level**: The study provides empirical evidence that supports information systems management models, confirming that digital transformation is the result of an interaction between a direct technical path and an indirect organizational (maturity) path.asjp.cerist
- **Practical level**: The study offers Sonatrach's decision-makers a roadmap showing that investing in "developing employees' capabilities" and "digital culture" (dimensions of maturity) is the key to maximizing the return from the SAP system.

Third: Study recommendations

Based on the results, the study recommends the following:

- **For Sonatrach's management**: The need to work on narrowing the gap by fully integrating field operations into the SAP system, in order to achieve complete "digital maturity".
- **Strengthening training and development**: Continuing specialized training programs not only on system usage skills, but also on understanding the philosophy of digital transformation as a whole.
- **Improving data quality**: Continuously auditing and enhancing the quality of information entered into the system, as it is the main input feeding decision-making processes and digital transformation.

Fourth: future prospects

- **Future prospects**: Based on the current study's results and limitations, it is proposed that future research address the following topics:
  - The effect of "digital leadership" as a moderating variable in the relationship between ERP systems and digital transformation: A comparative study between Sonatrach branches.
  - The role of "digital organizational culture" in strengthening the relationship between digital maturity and sustainable organizational performance.
  - Determinants of the success of digital transformation in Algerian public institutions: A comparative study between the hydrocarbons sector and the banking services sector.

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APPENDICES

Appendix (01) : Questionnaire

Questionnaire

Madam, Sir,

This questionnaire is part of a scientific research study aimed at analyzing the impact of the use of the ERP system on Digital Transformation within your institution.

We kindly ask you to answer the questions by ticking the corresponding box (X). Your answers are strictly anonymous and confidential.

Please tick the corresponding box (X).

"We appreciate your collaboration and thank you for your time."

Section I: General Information

Veuillez cocher la case correspondante (X) :

1. Gender : •Male ☐ • Female ☐

2. Age : • Moins de 30 ans ☐ • De 30 à 45 ans ☐ •Plus de 45 ans ☐

3. Educational level: • Secondary ☐ • University ☐ • post-graduate ☐

4. Professional experience: •Less than 5 years ☐ • From 5 to 10 years ☐

• More than 10 years ☐

5. Professional category: • Senior executive ☐ • Middle executive ☐

• Operational employee ☐

Section II: Main Body of the Questionnaire

Axis I: The ERP System

N°	STATEMENTS	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
SYSTEM QUALITY						
01	The ERP interface is simple and easy to use.					
02	Access to menus and data is easy.					
03	The system effectively links all departments to each other.					
04	Tasks are harmonized to form a single work cycle.					
05	The system supports a high workload.					
06	The system runs smoothly and without interruptions.					
INFORMATION QUALITY						
07	The system provides precise and accurate information.					
08	The reports generated by the system are error-free.					
09	The ERP provides information in real time.					
10	The system provides information at the right time for decision-making.					
11	The information is presented in a clear way.					
12	The available data cover all work needs.					

Axis II : DIGITAL MATURITY

N°	STATEMENTS	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
13	The institution has a clear plan for digital transformation.					
14	Management strongly supports the use of digital systems.					
15	The institution encourages employees to accept change.					
16	There is a sufficient level of awareness of the importance of digital technologies.					
17	The institution favors electronic transactions over paper-based ones.					
18	Work is carried out entirely on the system without manual registers.					
19	The institution provides appropriate equipment and networks.					
20	The current digital tools reduce human effort.					

Axis III : DIGITAL TRANSFORMATION

N°	STATEMENTS	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
21	The ERP system has made it possible to offer more advanced services.					
22	The ERP has created innovative working methods.					
23	The ERP offers clear interfaces for performing tasks.					
24	Employees are satisfied with the efficiency provided by the ERP.					
25	The ERP system has simplified the steps of administrative work.					
26	The ERP has accelerated the exchange of tasks between departments.					

Appendix (02):

Table 21 :List of Expert Judges for the Questionnaire

No.	Name and Surname	University
01	Balouli Houssam Eddin	Abbas Laghrour University - Khenchela
02	Kherri Abdennacer	School of Higher Commercial Studies Kolea – Algiers
03	Bouzidi Houda	Abbas Laghrour University - Khenchela

Source: Prepared by the student.

Appendix (03) : Academic Intership Application

كلية العلوم الاقتصادية والتجارية وعلوم التسيير
نيابة عمادة الكلية للدراسات فيما بعد التدرج
والبحث العلمي والعلاقات الخارجية
الرقم : 05 /ج.ع.ل.خ/ك.ع.ا.ت.ع.ت/2026

خنشلة في : 2026/02/04

إلى السيد : المدير الجهوي للنشاط النقل عبر
الأنابيب بحامي الرمل

الموضوع : في إطار التكوين في طور الماستر سنة ثانية تخصص إدارة أعمال

للطالبة: بخوش سناء

و تحت اشراف الأستاذ: بومعراف جعفر.

ونظرا لأهمية التربص ، يشرفنا أن نطلب من سيادتكم المحترمة الموافقة على استقبال الطالب المذكور أعلاه من أجل متابعة أعماله وإجراء تربصه بمؤسستكم.

في الأخير تقبلوا منا فائق الشكر والاحترام.

الاستاذ المؤطر :

رأي المؤسسة:

نائب عميد الكلية للدراسات فيما بعد التدرج
والبحث العلمي والعلاقات الخارجية:

خنافر علي

Chef Département RHU
SFAXI Samir Abdellah
11 FEV. 2026

Avis Favorable
A/c du 28/02/2026
au 07/03/2026

Appendix (04): Organizational Structure of Hassi R'Mel regional directorate

Appendix (05): Statistical Analysis Resultes

Statistical software used

1. IBM SPSS Statistics for Windows, Version 31.0.
2. SmartPLS 4 (https://www.smartpls.com).

Tests of Normality

	Kolmogorov-Smirnova		
	Statistic	df	Sig.
(Qualité du Système). 1	,178	69	,000
(Qualité de l'Information) .2	,162	69	,000
ERP	,155	69	,000
Maturité Numérique)	,110	69	,036
(Transformation Numérique)	,134	69	,004

Frequency Table

SEX

	N	%
Female	12	17,4%
Male	57	82,6%

AGE

	N	%
30 to 45 years	46	66,7%
Less than 30 years	13	18,8%
More than 45 years	10	14,5%

EDU

	N	%
Post-graduate	8	11,6%
University	61	88,4%

EXP

	N	%
5 to 10 years	34	49,3%
Less than 5 years	18	26,1%
More than 10 years	17	24,6%

CAT

	N	%
Middle Management	51	73,9%
Operational Staff	12	17,4%
Senior Management	6	8,7%

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
QS1	69	2	5	3,67	1,024
QS2	69	2	5	3,90	,877
QS3	69	1	5	4,07	,810
QS4	69	1	5	3,80	,797
QS5	69	3	5	4,04	,580
QS6	69	2	5	3,78	,968
(Qualité du Système). 1	69	2,50	5,00	3,8768	,56567
QI1	69	2	5	4,13	,784
QI2	69	1	5	3,72	1,042
QI3	69	1	5	3,94	,873
QI4	69	2	5	3,97	,840
QI5	69	1	5	3,65	1,041
QI6	69	1	5	3,12	1,051
(Qualité de l'Information) .2	69	2,33	5,00	3,7560	,63566

ERP	69	2,58	5,00	3,8164	,54413
MN 1	69	2	5	3,58	,930
MN 2	69	1	5	3,71	,925
MN 3	69	1	5	3,36	1,029
MN 4	69	1	5	3,64	,840
MN 5	69	1	5	3,33	1,120
MN 6	69	1	5	2,86	1,167
MN 7	69	2	5	3,93	,734
MN 8	69	1	5	3,51	,964
(Maturité Numérique)	69	2,00	5,00	3,4891	,60624
DV1	69	2	5	4,10	,789
DV2	69	2	5	3,80	,850
DV3	69	1	5	3,74	1,038
DV4	69	2	5	3,26	,816
DV5	69	1	5	3,52	1,066
DV6	69	2	5	3,77	,957
(Transformation Numérique)	69	2,00	5,00	3,6981	,69090
Valid N (listwise)	69				

Outer loadings

Matrix

	Digital Maturity	Digital Transformation	Enterprise Resource_ Planning (ERP)	Qualité de l'Information	Qualité du Système
DV1		0,806			
DV2		0,769			
DV3		0,813			

DV4		0,720			
DV5		0,669			
DV6		0,725			
MN 2	0,681				
MN 1	0,706				
MN 3	0,720				
MN 4	0,615				
MN 5	0,555				
MN 6	0,323				
MN 7	0,717				
MN 8	0,587				
QI1				0,759	
QI1			0,730		
QI2			0,557		
QI2				0,686	
QI3			0,647		
QI3				0,723	
QI4			0,699		
QI4				0,815	
QI5			0,655		
QI5				0,647	
QI6				0,462	
QI6			0,411		
QS1					0,527
QS1			0,464		
QS2					0,654
QS2			0,569		
QS3			0,690		
QS3					0,754
QS4			0,684		
QS4					0,734
QS5			0,617		
QS5					0,706
QS6			0,651		
QS6					0,655

Matrix

	Digital Maturity	Digital Transformation	Enterprise Resource_ Planning (ERP)	Qualité de l'Information	Qualité du Système
DV1		0,808			
DV2		0,776			
DV3		0,814			
DV4		0,719			
DV5		0,660			
DV6		0,721			
MN 2	0,773				
MN 1	0,747				
MN 3	0,751				
MN 4	0,627				
MN 7	0,723				
QI2			0,571		
QI2				0,742	
QI3			0,696		
QI3				0,823	
QI4				0,839	
QI4			0,701		
QI5			0,635		
QI5				0,610	
QS1			0,408		
QS2			0,549		
QS2					0,574
QS3			0,707		
QS3					0,756
QS4			0,712		
QS4					0,754
QS5					0,767
QS5			0,652		
QS6					0,697
QS6			0,665		

Construct reliability and validity

Overview

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
Digital Maturity	0,776	0,783	0,847
Digital Transformation	0,846	0,858	0,885
Enterprise Resource_ Planning (ERP)	0,855	0,859	0,885
Qualité de l'Information	0,788	0,795	0,857
Qualité du Système	0,755	0,766	0,836

Discriminant validity					
Heterotrait-monotrait ratio (HTMT) - Matrix					
Heterotrait-monotrait ratio (HTMT) - Matrix	Digital Maturity	Digital Transformation	Enterprise Resource_ Planning (ERP)	Qualité de l'Information	Qualité du Système
Digital Maturity					
Digital Transformation	0,726				
Enterprise Resource_ Planning (ERP)	0,562	0,793			
Qualité de l'Information	0,439	0,677	0,857		
Qualité du Système	0,643	0,848	0,877	0,853	

Inner model - Matrix

	Digital Transformation
Digital Maturity	1,287
Digital Transformation	
Enterprise Resource_ Planning (ERP)	1,287
Qualité de l'Information	
Qualité du Système	

R-square

Overview

	R-square	R-square adjusted
Digital Maturity	0,223	0,212
Digital Transformation	0,576	0,563
Qualité de l'Information	0,826	0,824
Qualité du Système	0,838	0,835

	Q^2predict	RMSE	MAE
Digital Maturity	0.183	0.928	0.736
Digital Transformation	0.448	0.767	0.596
Qualité de l'Information	0.815	0.445	0.347
Qualité du Système	0.825	0.433	0.338

f-square

Matrix

	Digital Maturity	Digital Transformation	Enterprise Resource_ Planning (ERP)	Qualité de l'Information	Qualité du Système
Digital Maturity		0,238			

Digital Transformation					
Enterprise Resource_ Planning (ERP)	0,287	0,493		4,762	5,161
Qualité de l'Information					
Qualité du Système					

Path coefficients

Mean, STDEV, T values, p values

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Digital Maturity -> Digital Transformation	0,360	0,372	0,105	3,444	0,001
Enterprise Resource_ Planning (ERP) -> Digital Maturity	0,472	0,493	0,098	4,829	0,000
Enterprise Resource_ Planning (ERP) -> Digital Transformation	0,519	0,513	0,096	5,379	0,000
Enterprise Resource_ Planning (ERP) -> Qualité de l'Information	0,909	0,912	0,024	37,244	0,000
Enterprise Resource_ Planning (ERP) -> Qualité du Système	0,915	0,919	0,019	48,690	0,000

Specific indirect effects

Mean, STDEV, T values, p values

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Enterprise Resource_ Planning (ERP) -> Digital Maturity -> Digital Transformation	0,170	0,185	0,071	2,410	0,016

Confidence intervals

	Original sample (O)	Sample mean (M)	2.5%	97.5%
Enterprise Resource_ Planning (ERP) -> Digital Maturity -> Digital Transformation	0,170	0,185	0,069	0,341