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**The Impact of Digital Transformation on Efficiency in
Economic Institutions: A Case Study of GCB in Boumerdes**

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Dedication

To my beloved parents, the greatest blessing in my life.

To my mother, the source of endless love and inspiration, whose care and prayers have always guided me.

To my father, whose wisdom and sacrifices remain my everlasting source of strength and determination.

To my dear siblings, my constant companions, who have filled my life with support and happiness.

To my respected professors, who have illuminated my path with knowledge, patience, and dedication.

To my dear friends:

- Khaoula chebouat
- Hind laouer
- Sara djebbas

who have been by my side, sharing moments of joy, support, and unforgettable memories.

And to everyone who believed in me and supported me throughout this journey.

I dedicate this humble work to all of you as a token of my sincere gratitude and appreciation.

Gratitude

In the name of Allah, the Most Gracious, the Most Merciful.

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Abstract:

This study examines the impact of digital transformation on efficiency within economic institutions, focusing on the National Company for Civil Engineering and Construction (GCB) in Boumerdes as a case study. The research aims to explore the reality of adopting digital tools and analyze their role in improving organizational performance and the flow of information among various departments (Finance, IT, HR, and Communication). The study relies on the descriptive approach, using direct observation and semi-structured interviews as primary data collection tools during the internship period. The results indicate that digital transformation contributes positively to increasing efficiency by accelerating administrative processes, reducing human errors, and enhancing data transparency, which supports accurate and rapid decision-making within the institution.

Keywords: Digital Transformation, Efficiency, Economic Institution, GCB Company, Digital Systems.

المخلص:

تتناول هذه الدراسة أثر التحول الرقمي على الكفاءة داخل المؤسسات الاقتصادية، مع التركيز على الشركة الوطنية للهندسة المدنية والبناء (GCB) ببومرداس كدراسة حالة. هدفت الدراسة إلى استكشاف واقع تبني الأدوات الرقمية وتحليل دورها في تحسين الأداء التنظيمي وسرعة تدفق المعلومات بين مختلف المصالح (المالية، الإعلام الآلي، الموارد البشرية، والاتصال). اعتمدت الدراسة على المنهج الوصفي، واستخدمت الملاحظة المباشرة والمقابلات نصف الموجهة كأدوات أساسية لجمع البيانات خلال فترة التربص وقد توصلت الدراسة إلى أن التحول الرقمي يساهم بشكل إيجابي في رفع مستوى الكفاءة من خلال تسريع العمليات الإدارية، تقليل الأخطاء البشرية وتعزيز الشفافية في تداول البيانات مما يدعم اتخاذ قرارات دقيقة وسريعة داخل المؤسسة.

الكلمات المفتاحية: التحول الرقمي، الكفاءة، المؤسسة الاقتصادية، شركة GCB ، الأنظمة الرقمية.

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List of Abbreviations:

Abbreviation	Full Term
AC	Average Cost
DT	Digital Transformation
DGI	Direction Générale des Impôts
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FEED	Front-End Engineering Design
GCB	Civil Engineering and Building
HRM	Human Resource Management
ICT	Information and Communication Technologies
IMS	Integrated Management System
LRAC	Long-Run Average Cost
ISO	International Organization for Standardization
IT	Information Technology
IMS	Integrated Management System
KPIs	Key Performance Indicators
LRAC	Long-Run Average Cost
MC	Marginal Cost
MES	Minimum Efficient Scale
MU	Marginal Utility
PMC	Private Marginal Cost
PPF	Production Possibility Frontier
PSC	Private Social Cost
SALT	Strategic Arms Limitation Talks
SFA	Stochastic Frontier Analysis
SMB	Social Marginal Benefit
SMC	Social Marginal Cost
XMC	External Marginal Cost



Introduction

Preface:

The contemporary business environment is experiencing profound transformations driven by the rapid development of Information and Communication Technologies (ICTs). These technological advances have reshaped the way organizations operate, communicate, and compete, creating new opportunities as well as new challenges. As a result, digital transformation has emerged as a strategic priority for organizations seeking to improve their performance, strengthen their competitiveness, and ensure their long-term sustainability in an increasingly dynamic environment.

Digital transformation is no longer limited to the simple use of computers or digital devices. Rather, it represents a comprehensive organizational transformation based on the integration of digital technologies into administrative, financial, operational, and communication processes. Through this transformation, organizations seek to improve information management, optimize resource utilization, accelerate work processes, and enhance decision-making capabilities. Consequently, digital transformation has become an essential component of modern organizational development.

At the same time, efficiency remains one of the most important objectives pursued by economic institutions. In a context characterized by intense competition, increasing customer expectations, and limited resources, organizations are expected to achieve higher levels of performance while minimizing costs, time, and effort. Efficiency therefore constitutes a key indicator of organizational success, reflecting the institution's ability to utilize its resources effectively and achieve its objectives under optimal conditions.

The growing interest in digital transformation has generated significant academic and professional attention regarding its contribution to efficiency. Numerous studies have highlighted the positive role of digital technologies in facilitating communication, automating routine tasks, improving data management, reducing operational errors, and enhancing coordination between organizational units. These advantages suggest that digital transformation may constitute an important driver of efficiency improvement within contemporary organizations.

In Algeria, digital transformation has become an integral part of modernization efforts undertaken by both public and private institutions. Various economic organizations have progressively adopted digital technologies to improve management practices, increase productivity, and enhance service quality. However, the degree of digital transformation and its impact on efficiency vary from one institution to another according to organizational, technological, and human factors.

Among the Algerian organizations engaged in this transformation process is GCB (Entreprise Nationale de Génie Civil et Bâtiment), one of the leading companies operating in the fields of civil engineering and construction. Due to the complexity of its activities and the scale of its projects, the company increasingly relies on digital technologies and information systems to support its administrative, financial, technical, and communication functions. This context

raises important questions regarding the effectiveness of these technologies and their contribution to improving efficiency within the company.

Based on this, the current study aims to explore the reality of digital transformation and its impact on efficiency within GCB. Accordingly, the research problem can be formulated in the following question:

To what extent does digital transformation contribute to improving efficiency within GCB?

Based on the research problem mentioned before, and to understand the topic better, we have divided the main problem into a few sub-questions as follows:

- What is the nature of the relationship between digital transformation and efficiency within the company?
- How does digital transformation influence work organization and internal communication?
- What are the main digital transformation practices adopted by GCB in its administrative, financial, and technical activities?

Research Hypotheses:

- The adoption of digital technologies improves the organization and execution of work processes within GCB.
- The use of digital systems contributes to reducing processing time, minimizing operational errors, and improving the utilization of organizational resources.
- Digital transformation enhances the flow of information and facilitates internal communication between departments.

Reasons for Choosing the Topic:

Personal Reasons:

- Academic Interest: My personal interest in understanding how modern technology changes the work environment and helps people work better.
- Practical Experience: The desire to apply what I learned in my studies to a real work environment, especially during my internship at GCB.

Objective Reasons:

- The Importance of the Topic: Digital transformation is now a necessity for all big companies to stay strong and successful in the market.

Study Objectives:

- To explore the reality of digital transformation in GCB:
The goal is to see how digital tools are actually used in different departments. We

want to identify the types of software and systems that the company uses in its daily work.

- To understand how technology affects work organization:
We want to see how digital systems change the way employees communicate and work together. This helps us know if technology makes the internal processes faster and more organized.
- To identify the link between digital tools and efficiency:
The main goal is to find out if using digital tools leads to better results, fewer mistakes, and saved time. This shows the real impact of digital transformation on the company's success.

Significance of the Study:

- **Scientific Significance :**
This study is important because it provides new and useful ideas about digital transformation in the Algerian context. It can help other students and researchers who want to study how technology affects efficiency in big companies. It adds a practical example to the library for future research.
- **Practical Significance :**
This study is important for GCB because it shows the real impact of their digital tools on daily work. The results can help the company understand its strengths and find ways to improve its systems. This leads to better decision-making and helps the business stay strong and successful.

Scope of the Study:

- **Spatial Scope :**
The study is limited to the GCB company, specifically at the main headquarters located in Boumerdes. This is where we conducted our field research and observations.
- **Temporal Scope :**
The empirical study was conducted during the internship period in April 2026. This period was used to collect data through interviews and direct observation.
- **Thematic Scope :**
The research focuses only on the impact of digital transformation on efficiency within the company. We focus on how digital tools help in making work faster and more correct.

Research Methodology and Tools:

In this study, we used the Descriptive Approach, which is the most suitable method to describe the reality of digital transformation inside the company and analyze its impact on efficiency. To collect the necessary data, we relied on two main tools: Direct Observation to see how digital systems are used in daily tasks, and Semi-Structured Interviews with employees from different departments, such as Information Technology (IT), Finance, HR, and Communication, to get clear and direct information.

Research Difficulties:

During this study we faced some challenges that made the work more difficult:

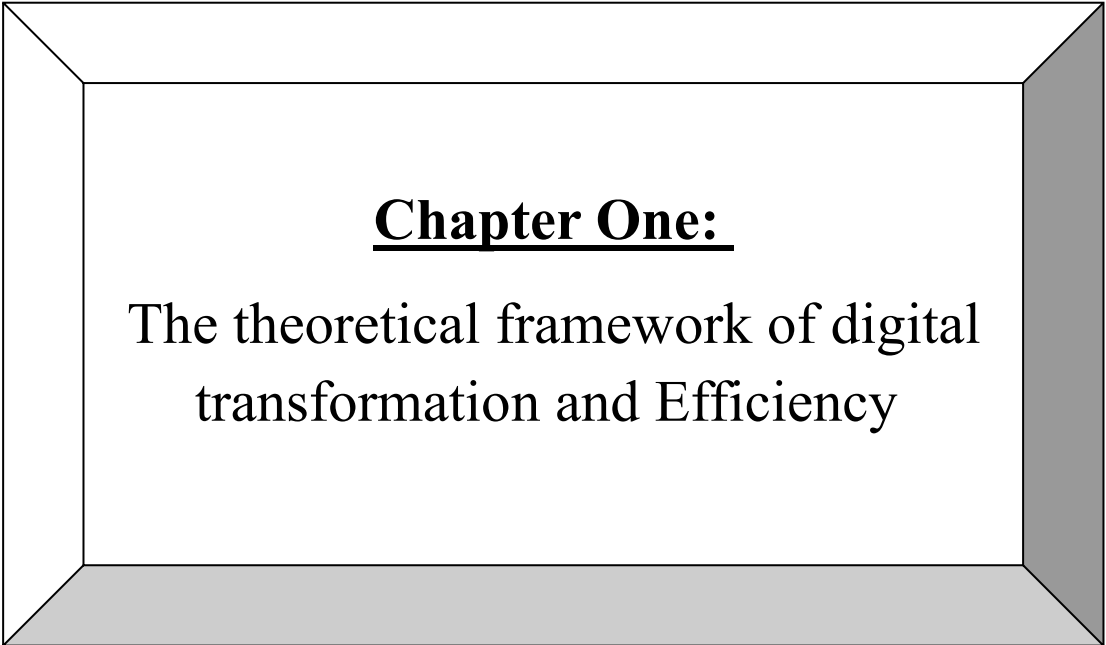
- Time constraints: The period of the internship was very short, which made it hard to conduct more interviews or collect more data.
- Data access: It was not easy to get some internal information because of the company's privacy and information security rules.
- Measuring efficiency: It was challenging to measure "efficiency" perfectly because the work operations inside GCB are very complex.

Research Structure:

We divided the study into two main chapters:

The first chapter titled: "The Theoretical Framework of Digital Transformation and Efficiency" consists of two main sections: The first section provides a conceptual framework for digital transformation, including its definitions, types and challenges. The second section focuses on the theoretical framework of efficiency in economic institutions.

The second chapter titled: "Empirical Study of the Impact of Digital Transformation on Efficiency: Case Study of GCB in Boumerdes" is dedicated to the practical research. It begins with a presentation of the host institution (GCB) and explains the research methodology and data collection tools. Finally it includes a discussion of the results of digital transformation practices within the different departments of the company.



Chapter One:

The theoretical framework of digital
transformation and Efficiency

Chapter One: The theoretical framework of digital transformation and Efficiency

Preface:

Today, digital transformation has become very important for economic institutions. By using modern technologies, organizations can improve their work and use their resources more efficiently.

In this chapter, we will discuss the following topics:

- 1. Conceptual and methodological framework of digital transformation.**
- 2. Theoretical Framework of Efficiency in Economic Institutions.**
- 3. Review of previous studies.**

1. Conceptual and methodological framework of digital transformation:

Given the growing importance of digital transformation in economic institutions, there has been a need to establish a conceptual and methodological framework to better understand this concept.

Accordingly, this section aims to provide a comprehensive overview of digital transformation through its definition, main characteristics, key dimensions, and its role in improving organizational performance.

1.1 Definition of Digital Transformation:

Digital transformation has several definitions in the academic literature, as researchers and international organizations have provided different interpretations. However, they all converge toward a common meaning related to the use of digital technologies to improve organizational performance and efficiency. The most important definitions are presented as follows:

- Digital transformation is the process through which organizations use digital technologies to fundamentally redesign their business models and operations. It goes beyond simple automation, as it aims to create more responsive and flexible organizations capable of adapting to changing market demands. This transformation affects how value is created and delivered to customers and often leads to significant changes in organizational structure and strategy.¹
- It is also defined as the integration of digital technologies into organizational processes to enhance performance and improve decision-making. Through this process, organizations become more efficient in managing resources and responding to environmental changes. Digital transformation also supports innovation by enabling faster access to information and improved communication systems within the organization.²
- Digital transformation can also be defined as a comprehensive process through which organizations and societies use digital technologies to fundamentally change their operations, processes, products, and services. It enables institutions to achieve higher levels of efficiency, innovation, and adaptability within a rapidly evolving digital environment. This transformation involves the integration of advanced technologies such as cloud computing, big data, artificial intelligence, and the Internet of Things, leading to improved performance and competitiveness across different sectors³.

¹ -Lozić, J., & Fotova Čiković, K. (2024). *Digital transformation: The fundamental concept of transformation of business activities. Economic and Social Development* (107th International Scientific Conference on Economic and Social Development – Economic and Social Survival in Global Changes), p 4. Retrieved April 01, 2026, from https://www.researchgate.net/publication/379257824_DIGITAL_TRANSFORMATION_THE_FUNDAMENTAL_CONCEPT_OF_TRANSFORMATION_OF_BUSINESS_ACTIVITIES.

² - Vial, G. (2019). *Understanding digital transformation: A review and a research agenda. Journal of Strategic Information Systems*, 28(2), p 5. Retrieved April 01, 2026, from <https://doi.org/10.1016/j.jsis.2019.01.003>.

³- Boutrik, S. (2025). *The role of digital transformation in strengthening economic growth in Arab countries. Journal of Contemporary Business and Economic Studies*, 8(1), p3. Retrieved April 01, 2026, <https://asjp.cerist.dz/en/article/262705>.

- Digital transformation refers to the ability of organizations to adapt to rapid technological changes by modifying their business models, strategies, and organizational culture in order to maintain competitiveness. It also involves converting traditional information sources such as documents, books, and media into digital formats that can be processed using modern technologies. Overall, it represents a shift from traditional methods of managing information to faster and more efficient digital systems that facilitate communication and administrative processes.¹

❖ Based on the previous definitions, digital transformation can be defined as a continuous and comprehensive process of integrating digital technologies into all aspects of organizations in order to improve performance, increase efficiency, enhance innovation, and strengthen competitiveness in a rapidly changing digital environment.

1.2 Types of Digital Transformation:

Digital transformation can be classified into several types depending on the scope and objectives within organizations. These types reflect the different ways through which digital technologies are adopted to improve performance, create value, and enhance competitiveness. The main types of digital transformation can be presented as follows:

- **Process Transformation:**

This type focuses on improving internal operations by integrating digital technologies such as automation data analytics, and advanced information systems. It aims to enhance efficiency reduce operational costs, and optimize workflows within the organization.

- **Business Model Transformation:**

This type involves redefining the way organizations create and deliver value to customers. It includes the development of new business models, digital platforms, and innovative services that generate new revenue streams and improve customer experience.

- **Domain Transformation:**

Domain transformation occurs when organizations expand into new markets or industries through the use of digital technologies. This allows institutions to explore new opportunities and diversify their activities beyond traditional boundaries.

- **Organizational Transformation:**

This type emphasizes changes in organizational structure, culture, and employee competencies to support digital innovation. It involves adopting a digital mindset enhancing skills, and encouraging flexibility and collaboration within the organization.²

¹ - Chebaiki, H. (2024). *Digital Transformation in the Algerian University – Between Reality and Aspiration*. *The Journal of El-Ryssala for Studies and Research in Humanities*, 9(4), p 2. Retrieved April 01, 2026,from <https://asjp.cerist.dz/en/article/258752>.

² - Boutrik, S. Previous reference.pp.3-4.

1.3 Digital Transformation Features:

Digital transformation characterized is by several key features that reflect its impact on organizational performance and development. These features can be summarized as follows:

- **Agility and Adaptability:**

Digital technologies enable organizations to respond quickly and effectively to environmental and market changes, allowing them to remain flexible and competitive.

- **Transformation of the Value Creation Process:**

Digital transformation contributes to the creation of new value by enabling organizations to redesign their services and products in a more innovative efficient and customer-oriented way.

- **Organizational and Structural Change:**

Digital transformation requires organizations to restructure their systems create new roles and develop employee skills in line with technological developments. It also supports cultural change by encouraging innovation reducing routine work and enhancing employee involvement in technology-based initiatives.

- **Customer Communication:**

Digital platforms and interfaces facilitate communication between organizations customers and business partners. This strengthens relationships with stakeholders and increases participation in projects which ultimately improves organizational performance.

- **Digitization of Processes:**

This feature refers to converting traditional paper-based processes into digital formats using information technologies. It improves efficiency by enabling faster data processing, better storage, and more effective time management.¹

1.4 Dimensions of Digital Transformation:

Digital transformation is a multidimensional process that involves several interrelated dimensions. These dimensions interact with each other to enable organizations to achieve their objectives, improve performance, and strengthen competitiveness in a rapidly evolving digital environment. The most important dimensions can be presented as follows:

- **Technological Dimension:**

This dimension refers to the adoption and integration of advanced digital technologies such as artificial intelligence, cloud computing, big data, and the Internet of Things.

¹ Benyahia, B., & Guettafi, S. (2025). *The impact of digital transformation on organizational performance: A case study of Algeria Telecommunication corporations*, Batna. Algerian Journal of Public Finance, 15(2), p. 4. Retrieved April 02, 2026, from <https://asjp.cerist.dz/en/article/282623>.

Chapter One: The theoretical framework of digital transformation and Efficiency

These technologies play a fundamental role in improving operational efficiency and enabling innovation within organizations.

- **Organizational Dimension:**

This dimension focuses on transforming organizational structures and processes, as well as promoting flexibility and innovation. It allows organizations to better adapt to environmental changes and respond effectively to digital challenges.

- **Economic Dimension:**

This dimension focuses on achieving economic benefits such as cost reduction, productivity improvement, and better financial performance through the effective use of digital technologies.

- **Social Dimension:**

Digital transformation has significant social implications, including its impact on employment, skills development, and the role of organizations in promoting social responsibility through digital initiatives.¹

- **Strategic Dimension:**

This dimension involves the development of digital strategies that aim to create new value and improve competitiveness. It also includes the redesign of business models and the integration of digital technologies into long-term organizational planning.²

- **Customer Dimension:**

Digital transformation enhances customer experience by providing personalized fast and efficient digital services. It places the customer at the center of organizational activities and decision-making processes.³

- **Human Dimension :**

The human dimension emphasizes the importance of developing employees' digital skills and enhancing their ability to adapt to technological changes. It also includes motivating employees to actively participate in the digital transformation process.⁴

¹ - Abidi, O., Richet, J.-L., & Vitari, C. (2025). *Digital Transformation and Resilience: Dimensions and Interactions*. *Journal of Global Information Management*, 33(1), pp. 8–13. Retrieved April 03, 2026 from <https://doi.org/10.4018/JGIM.367873>.

² - Wurm, B., Matt, C., Benlian, A., & Hess, T. (2025). *A revised framework for digital transformation strategies: Contemporary insights and future research pathways*. *Electronic Markets*, 35(99), pp. 9–10. Retrieved April 03, 2026, from <https://doi.org/10.1007/s12525-025-00838-z>.

³ - Kao, L.-J., & Wu, J. (2024). *Unveiling the dimensions of digital transformation: A comprehensive taxonomy and assessment model for business*. *Journal of Business Research*, 176(114595). Retrieved April 03, 2026, from <https://doi.org/10.1016/j.jbusres.2024.114595>.

⁴ - Abdelaziz, M., & Naama, A. (2023). *The impact of digital transformation dimensions on the employees job performance: Applying on four and five star hotels in the Red Sea Governorate*. *Journal of Association of Arab Universities for Tourism and Hospitality*, 24(1), p. 3. Retrieved April 03, 2026, from <https://jaauth.journals.ekb.eg>.

1.5 Importance and Objectives of Digital Transformation:

Digital transformation has become a key driver of organizational and economic development in the modern era. It represents a strategic shift that enables institutions to integrate digital technologies into their operations, improve performance, and adapt to continuous technological changes.

1.5.1 Importance of Digital Transformation:

Digital transformation has become an essential requirement for organizations seeking to improve their performance and adapt to technological developments. It contributes to enhancing the efficiency of organizational processes through the integration of digital technologies into different activities and functions. Furthermore, digital transformation facilitates information management, improves communication and coordination between departments, accelerates the execution of tasks, and supports decision-making through the availability of accurate and timely information. It also creates opportunities for innovation and enables organizations to strengthen their competitiveness in an increasingly digital environment.¹

Objectives of Digital Transformation:

The main objective of digital transformation is to improve organizational efficiency by integrating digital technologies into all operational and administrative processes. It also aims to modernize institutional systems and enhance their flexibility and responsiveness to environmental changes. Another key objective is to improve service delivery by making services more accessible, faster, and more efficient for users. Digital transformation also seeks to promote innovation by supporting the development of new products, services, and business models aligned with digital advancements. Furthermore, it aims to strengthen decision-making processes by relying on accurate and real-time data analysis. Ultimately, digital transformation contributes to enhancing the competitiveness of organizations and ensuring their long-term adaptability in a dynamic digital environment.²

¹ - Salougui, G., Nekhmi, C. T., & Al-Absi, A. (2021). The Reality and Importance of Digital Transformation and Automation. *Journal of Opinions for Economic and Administrative Studies*, 3(2), 99–109, p. 106.

² - OECD (2019). *Going Digital: Shaping Policies, Improving Lives*. OECD Publishing, Paris. Retrieved April 03, 2026, from <https://doi.org/10.1787/9789264312012-en>.

1.6 Challenges of Digital Transformation:

Digital transformation is associated with several challenges that differ according to organizational context and technological readiness. These challenges can be grouped based on their sources in the literature as follows:

- **Lack of Technical Skills and Human Resource Limitations:**
One of the major challenges is the lack of technical skills among employees within organizations. Many workers do not possess sufficient digital competencies required to operate modern technologies effectively. This skills gap affects the planning and implementation of digital strategies and reduces organizational readiness for transformation. In addition, the inefficiency and limited experience of staff in dealing with digital tools further complicate the transition process.
- **Weak IT Infrastructure and Technological Limitations:**
The weakness of information and communication technology infrastructure is also a major obstacle. Many organizations face issues related to outdated equipment, limited technological resources, and insufficient digital systems. These limitations reduce the efficiency of digital transformation and slow down technological integration processes.¹
- **Organizational Culture and Resistance to Change:**
Organizational culture represents a significant barrier to digital transformation. Many institutions are characterized by traditional hierarchical structures, rigid norms, and resistance to change. Such cultural patterns hinder the adoption of new digital initiatives unless a strong digital mindset and openness to innovation are established. Resistance to change from employees and managers can slow down or even block transformation processes.
- **Weak Coordination and Communication Issues:**
Another important challenge is the lack of effective coordination and communication between different organizational levels. Poor communication leads to unclear roles and responsibilities, which negatively affects the implementation of digital strategies. Therefore, precise definition of tasks and improved collaboration between departments are essential to ensure successful transformation.
- **Security Risks and Regulatory Constraints:**
Digital transformation increases exposure to information security risks, including cyberattacks, data breaches, and privacy issues. Organizations must implement strong cybersecurity systems to protect sensitive data and ensure compliance with regulations. Additionally, legal frameworks and administrative regulations may slow down digital transformation processes and limit their effectiveness.²

¹ - Arribi, C., & Boutarfa, S. (2024). Digital Transformation: Opportunities and Challenges of Digitization in Algeria. *Economic Researcher Review*, 12(1), p. 7. Retrieved April 03, 2026, from <https://asjp.cerist.dz/en/downArticle/85/12/1/249388>.

² - Hassani, O., & Boubegra, N. (2023). Innovative Digital Practices: Enhancing the Effectiveness of Human Resource Management in the Digital Transformation Era. *Finance and Business Economics Review*, 7(4), pp. 9–10. Retrieved April 03, 2026, from <https://asjp.cerist.dz/en/article/239645>.

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- **Resource Readiness and Leadership Challenges:**

Successful digital transformation requires sufficient financial resources advanced technological infrastructure and skilled human capital. However many organizations struggle with limited budgets and lack of qualified personnel. Furthermore the absence of strong leadership with digital expertise and strategic vision creates a significant barrier to effective transformation. The shortage of specialists in areas such as artificial intelligence, data analytics, and cloud computing also represents a major challenge.¹

2. **Theoretical Framework of Efficiency in Economic Institutions:**

Efficiency is a fundamental concept in economics, particularly within economic institutions, where it is closely linked to the optimal use of available resources and the achievement of organizational objectives. It plays a crucial role in improving performance, enhancing productivity, and ensuring rational resource allocation. This section aims to present the theoretical framework of efficiency by explaining its concept and definitions, as well as highlighting its main types and methods of measurement.

2.1. **Concept of Efficiency:**

The concept of efficiency in economic thought is closely linked to the fundamental economic problem, which concerns how to allocate limited resources in order to satisfy the unlimited and continuously evolving needs and wants of individuals. Scarcity, as a central concept in economics, implies that resources are finite and cannot meet all human demands simultaneously.

Therefore, allocating resources to one sector necessarily involves an opportunity cost in another. For instance, allocating more resources to the industrial sector may come at the expense of other sectors such as health or education, which may consequently receive insufficient resources. As a result, economic policies and societies focus on the optimal use and allocation of scarce resources, recognizing that such resources are valuable and should not be wasted.

From this perspective, efficiency can be simply defined as the absence of waste in the use of scarce resources. Historically, the concept of efficiency was further developed by the Italian economist Vilfredo Pareto (1848–1923), who introduced the concept of Pareto optimality. According to this approach, a resource allocation is considered efficient if it is impossible to improve the well-being of one individual without reducing the well-being of another. Conversely, any allocation that does not meet this condition is regarded as inefficient.²

¹ - Hassani, O., & Boubegra, N. (2023), Previous reference, p10.

² - Friedman, L. S. (2002). The Microeconomics of Public Policy Analysis. Princeton, USA: Princeton University Press, p. 26.

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This concept of efficiency also extends to different levels of economic analysis, including the consumer, the producer, and the economy as a whole. In this regard, the allocation of goods among consumers is considered Pareto efficient if it is impossible to reallocate goods in a way that increases the satisfaction of one or more consumers without reducing the satisfaction of others.

Similarly, the allocation of factors of production among goods and services is said to be Pareto efficient if it is impossible to reorganize production in such a way that the output of one good (or several goods) increases without reducing the output of another. At the macroeconomic level, the economy is considered to be in a general equilibrium and an optimal situation when both the allocation of resources in production and the distribution of goods and income among consumers are Pareto efficient.¹

However, in practical reality, this concept of efficiency faces certain exceptions, particularly in the case of military expenditure allocated for national defense. This arises due to the lack of mutual trust among states and the increasing perception of threat, where each country tends to increase its defense spending. This, in turn, reinforces the sense of insecurity, creating a continuous cycle of escalating military expenditure, a situation known in economic theory as the “Prisoner’s Dilemma.” From a theoretical perspective, neoclassical economic theory suggests that the price mechanism is capable of achieving optimal resource allocation and efficiency in the economy. However, issues related to military expenditure cannot be effectively resolved through market mechanisms alone. Instead, they require negotiation and international dialogue, as illustrated by the Strategic Arms Limitation Talks (SALT) between the former Soviet Union and the United States of America.²

- ❖ Based on the above, economic efficiency can be understood as the optimal use and allocation of scarce resources in a way that minimizes waste and maximizes social welfare. It is grounded in the principle of Pareto efficiency and applies to consumers, producers, and the economy as a whole. However, in practice, its full realization may be constrained by strategic interactions and lack of cooperation between economic agents, as illustrated by the Prisoner’s Dilemma, which often leads to inefficient outcomes.

2.2. Definition of Efficiency:

Efficiency is considered a fundamental concept in economic analysis, as it plays a crucial role in understanding how scarce resources are allocated and utilized within an economy. It is closely linked to the idea of achieving the maximum possible output or level of satisfaction from a given set of limited resources, while avoiding any form of waste or misallocation. However the concept of efficiency is not defined in a single unified way, as it varies according to different economic perspectives and theoretical approaches. Some definitions focus on social welfare and the overall benefits gained by society, while others emphasize production performance, cost minimization, or the technical relationship

¹ - Salvatore, D. (2008). *Microéconomie: Cours et Problèmes*. Paris, France: McGraw-Hill Education, p. 246.

² - Friedman, L. S., Previous reference .p. 46.

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between inputs and outputs. Due to this diversity in interpretation, it becomes necessary to present multiple definitions of efficiency in order to capture its different dimensions. The following section, therefore, provides a set of definitions that reflect these various perspectives and help in building a clearer and more comprehensive understanding of the concept of efficiency:

- **Mankiw's Perspective on Social Benefit:**

Efficiency is the property of society getting the maximum benefits from its scarce resources. It refers to the size of the economic pie, ensuring that resources are allocated in a way that maximizes the total utility or satisfaction derived by all members of society.¹

This definition emphasizes the relationship between efficiency and social welfare, as it focuses on maximizing the overall benefits obtained from limited resources. It highlights that efficient allocation is not only about production but also about ensuring that resources contribute to the greatest possible level of satisfaction for society as a whole. In this context, efficiency reflects the optimal distribution of resources in a way that avoids waste and enhances collective well-being.

- **McConnell's View on Resource Allocation:**

Efficiency refers to the use of resources in a way that maximizes the production of goods and services. It implies that an economy is operating on its production possibilities frontier, where it is impossible to produce more of one product without sacrificing the production of another.²

This definition focuses on productive efficiency, as it highlights the importance of utilizing all available resources to their fullest potential. It shows that an economy reaches efficiency when it operates at the boundary of its production possibilities, meaning that resources are fully employed and optimally allocated. Any point inside the frontier reflects inefficiency, where resources are either underutilized or misallocated.

- **Coelli's Technical and Productive Approach:**

Efficiency can be defined as the comparison between observed and optimal values of output and input. It represents the ability of a firm to obtain maximum output from a given set of inputs (output-oriented) or to produce a given output using minimum inputs (input-oriented).³

This definition introduces a more technical perspective on efficiency, particularly in production analysis. It emphasizes measurement and evaluation by comparing actual performance with the best possible performance. In this context, efficiency is closely linked to productivity, cost reduction, and technological performance making it an essential concept in assessing the performance of firms and institutions.

¹ - Mankiw, N. G. (2011). *Principles of Economics*. Mason, USA: South-Western Cengage Learning, p. 5.

² - McConnell, C., Brue, S., & Flynn, S. (2018). *Economics: Principles, Problems, and Policies*. New York, USA: McGraw-Hill Education, p. 15.

³ - Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An Introduction to Efficiency and Productivity Analysis*. New York, USA: Springer, p. 3.

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- **Salvatore's Focus on System Performance:**

Efficiency represents a situation in which it is impossible to improve the well-being of one person without harming another. In a production context, it signifies the allocation of resources to their most productive uses to ensure that waste is eliminated from the economic system.¹

This definition combines both allocative and productive efficiency by linking resource allocation to overall system performance. It reflects the idea that efficiency requires not only maximizing output but also ensuring that resources are distributed in a way that benefits society without creating losses elsewhere. It also highlights the importance of eliminating inefficiencies that arise from poor management or lack of competition.

- **Deepashree's Foundational Definition:**

Efficiency is a state where available resources are utilized to their fullest potential to achieve the best possible outcome. It involves the optimal combination of inputs to produce the highest attainable level of output, thereby minimizing cost and avoiding misallocation.²

This definition provides a simplified yet comprehensive understanding of efficiency, focusing on optimal resource utilization and cost minimization. It underlines that efficiency is achieved when resources are used in the best possible way to generate maximum results while avoiding waste, making it a fundamental principle in economic decision-making.

2.3. Types of Efficiency:

Efficiency can be classified into different types, each reflecting a specific aspect of how resources are used. These types help to better understand production, allocation, and overall economic performance.

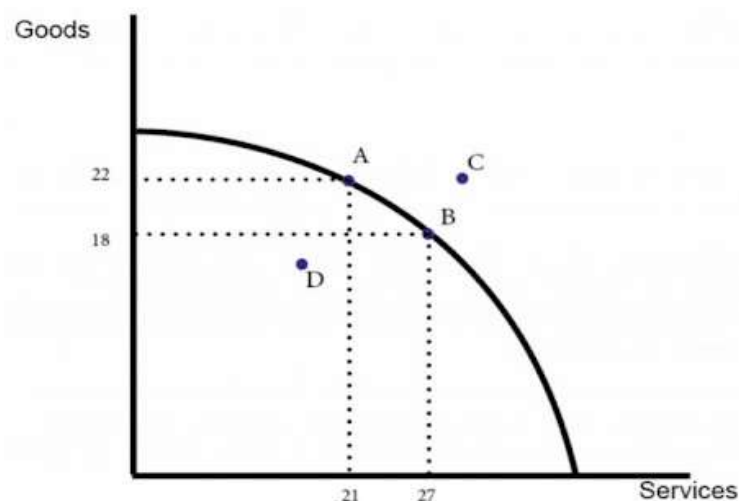
¹ - Salvatore, D. (2006). Microeconomics (Schaum's Outline Series). New York, USA: McGraw-Hill Companies, Inc., p. 314.

² - Deepashree, Dr. (2018). Introductory Microeconomics. New Delhi, India: New Saraswati House (India) Pvt. Ltd., p. 1.8.

▪ **Productive Efficiency:**

Productive efficiency occurs when the maximum amount of goods and services is produced using a given set of inputs. It is achieved when production takes place on the production possibility frontier, where it is impossible to increase the output of one good without reducing the output of another. It is also associated with production at the lowest point on the firm's average cost curve, reflecting minimum production costs and the absence of waste.

Figure 1: Production Possibility Frontier (PPF)



Source: Adapted from Economics Help (2023)

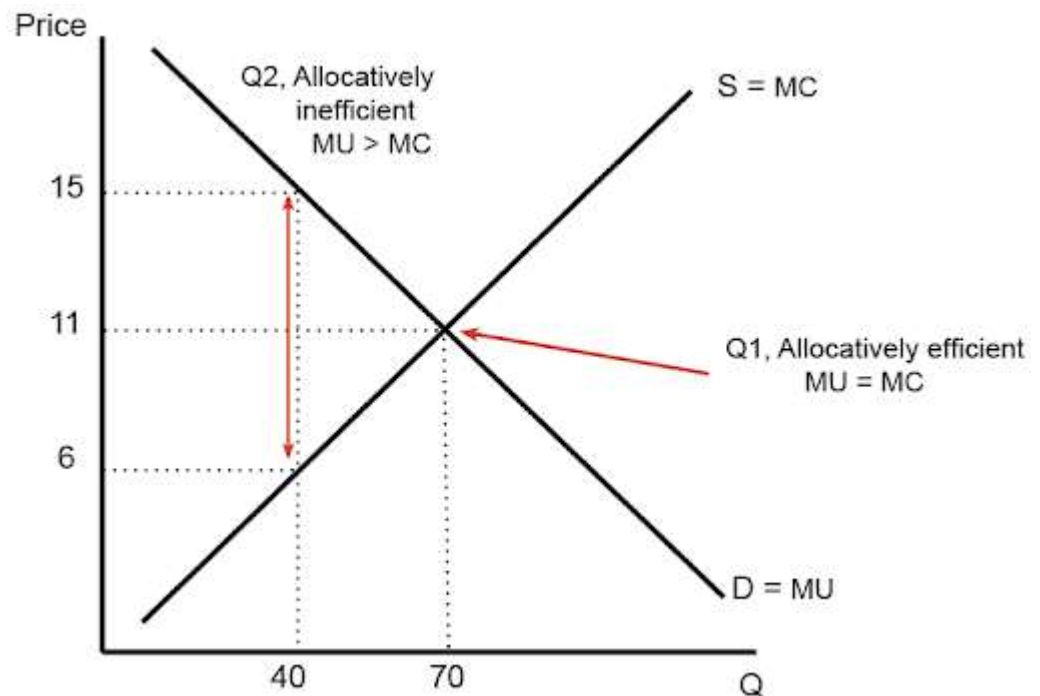
The Production Possibility Frontier (PPF) serves as a benchmark for economic efficiency. Points A and B on the frontier signify productive efficiency, where resources are fully utilized, and any increase in one output requires a trade-off in another (opportunity cost). Conversely, point D inside the curve indicates inefficiency due to underutilized resources, while point C outside the curve represents an unattainable production level under current technological and resource constraints. Ultimately, efficiency is achieved only by operating on the boundary of the frontier.¹

¹ - Tejvan Pettinger, "Economic Efficiency," Economics Help, June 28, 2023, Retrieved April 15, 2026, from <https://www.economicshelp.org/blog/2412/economics/economic-efficiency/>.

▪ Allocative Efficiency:

Allocative efficiency occurs when resources are distributed in a way that reflects consumer preferences and maximizes social welfare. It is achieved when the price of a good equals its marginal cost ($P = MC$), ensuring that resources are allocated to produce the goods most valued by society.

Figure 2: Allocative Efficiency and the Equilibrium Point ($MU = MC$)



Source: Adapted from Economics Help (2023)

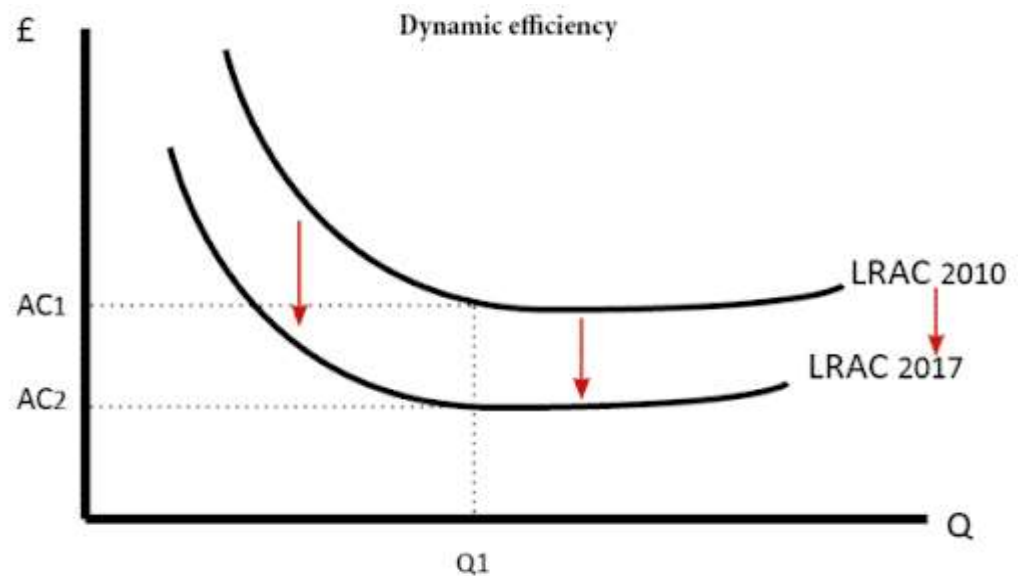
The provided diagram illustrates that allocative efficiency is achieved at quantity Q1 (70 units), where the intersection of the demand curve (MU) and the supply curve (MC) at a price of \$11 signifies that the marginal benefit to society perfectly aligns with the marginal cost of production. In contrast, at quantity Q2 (40 units), the market is allocatively inefficient because the marginal utility consumers derive from the product—valued at \$15—is significantly higher than the \$6 cost of producing it. This vertical gap between MU and MC indicates an under-allocation of resources, suggesting that societal welfare could be improved by increasing output until the equilibrium at Q1 is reached, where the additional utility no longer exceeds the additional cost.¹

¹ - Tejvan Pettinger, Previous reference.

▪ Dynamic Efficiency:

Dynamic efficiency refers to the ability of an economy or firm to improve its productive performance over time through innovation, investment, and technological progress. It focuses on long-term efficiency by reducing costs and enhancing the quality and quantity of output.

Figure 3: Dynamic Efficiency and Long-Run Cost Curves



Source: Adapted from Economics Help (2023)

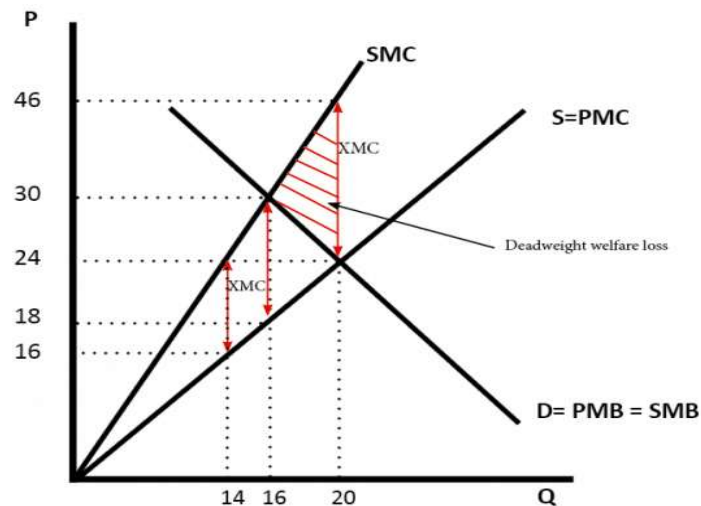
As illustrated in Figure 3, dynamic efficiency is represented by a downward shift of the Long-Run Average Cost (LRAC) curve over time. In 2010, the firm operated on the LRAC 2010 curve, with an average cost of AC1 for the output level Q1. However, due to continuous innovation and technological progress, the entire cost structure shifted downward to LRAC 2017. This shift allows the firm to produce the same quantity (Q1) at a significantly lower average cost (AC2). This progression demonstrates that dynamic efficiency is not merely about moving along an existing curve, but rather about fundamentally transforming production capabilities to achieve superior long-term performance and cost reduction.¹

¹ - Tejvan Pettinger, Previous reference.

▪ Social Efficiency:

Social efficiency occurs when both private and external costs and benefits are taken into account. It is achieved when social marginal cost equals social marginal benefit ($SMC = SMB$), ensuring maximum welfare for society.

Figure 4: The Socially Optimum Level of Output and Social Efficiency



Source: Adapted from Economics Help (2023)

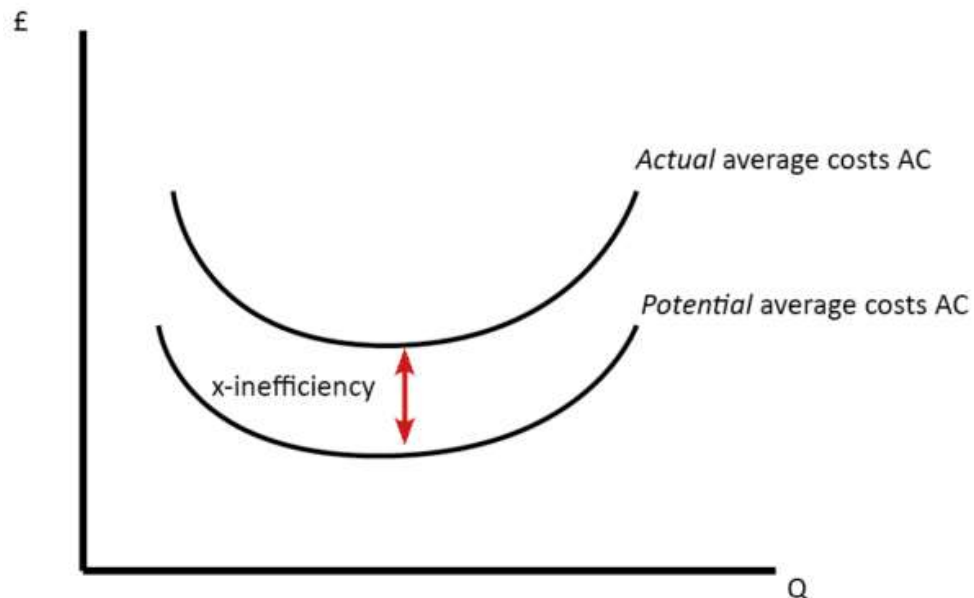
The provided diagram illustrates a market with a negative externality, where the Social Marginal Cost (SMC) exceeds the Private Marginal Cost (PMC) due to external costs (XMC). Market equilibrium occurs at a quantity of 20 units, where demand (PMB/SMB) intersects the private supply curve (PMC) at a price of \$24. However, the socially optimum level of production is at 16 units, where the demand curve intersects the SMC at a price of \$30. Producing at the market equilibrium (20 units) instead of the social optimum results in over-consumption, where the cost to society (\$46 on the SMC curve) far outweighs the benefit to consumers (\$24 on the SMB curve). This inefficiency is represented by the shaded triangle, known as the Deadweight Welfare Loss, which signifies the reduction in total societal welfare due to the presence of external costs that are not internalized by the market.¹

¹ - Tejvan Pettinger, Previous reference.

▪ X-Efficiency:

X-efficiency refers to the extent to which firms use their resources efficiently in practice. It highlights the gap between actual output and the maximum possible output, which may arise due to lack of competition, poor management, or weak incentives.

Figure 5: X-Inefficiency and the Gap Between Actual and Potential Average Costs



Source: Adapted from Economics Help (2023)

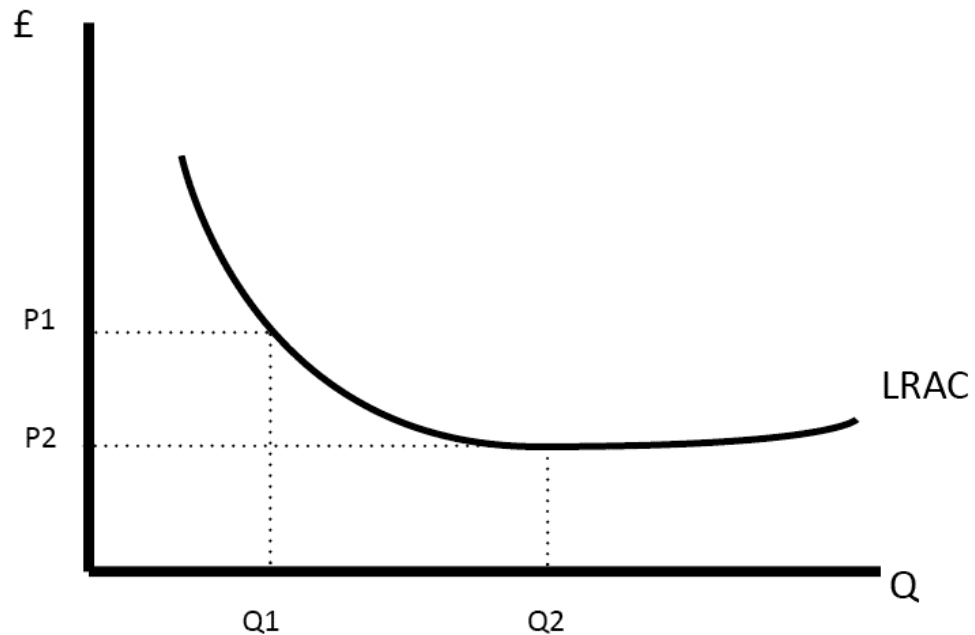
The diagram illustrates X-inefficiency, which occurs when a firm fails to minimize its costs of production due to a lack of competitive pressure, often seen in monopolies. As shown in the graph, the firm operates on the Actual Average Costs (AC) curve, which sits above the Potential Average Costs (AC) curve. The vertical distance between these two curves represents the degree of X-inefficiency. This gap indicates that the firm is producing its output at a higher average cost than is technically possible. This waste often results from organizational slack, lack of innovation, or inefficient management, where the firm is not motivated to exploit its available resources to the fullest potential.¹

¹ - Tejvan Pettinger, Previous reference.

▪ Efficiency of Scale:

Scale efficiency occurs when a firm operates at its optimal size, where average costs are minimized. It is achieved at the lowest point of the long-run average cost (LRAC) curve, allowing the firm to fully benefit from economies of scale.

Figure 6: Economies of Scale and the Reduction of Long-Run Average Costs



Source: Adapted from Economics Help (2023)

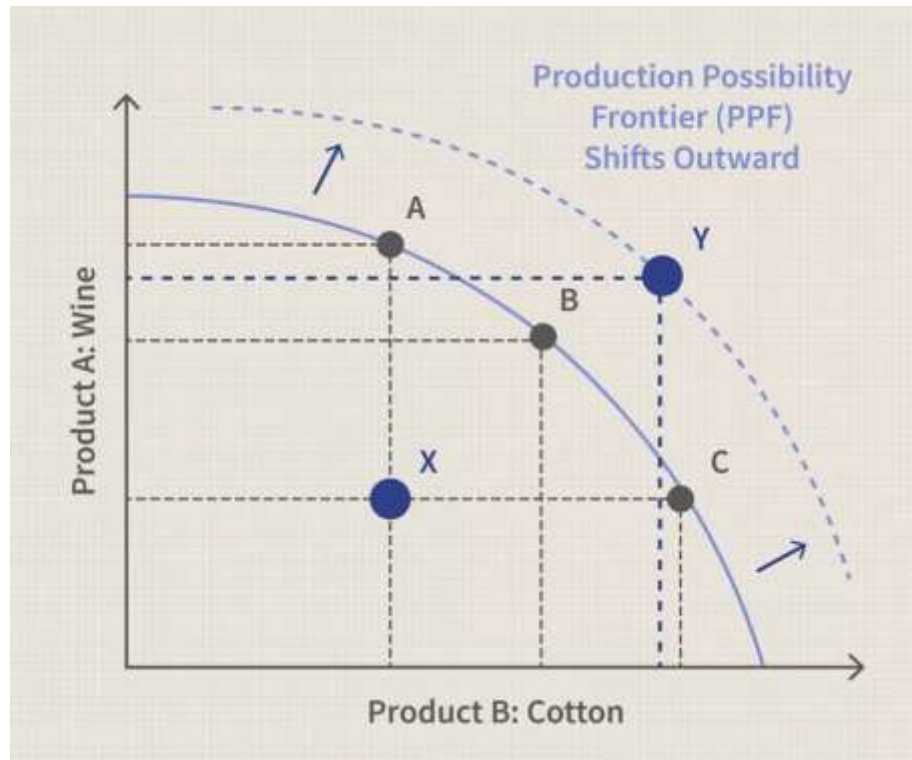
The diagram illustrates the concept of Economies of Scale, which occurs when a firm experiences a reduction in average costs as the scale of production increases in the long run. As observed on the Long-Run Average Cost (LRAC) curve, an expansion in output from Q1 to Q2 leads to a significant decline in the unit cost from P1 to P2. This downward slope reflects the internal efficiencies gained through factors such as bulk purchasing, technical improvements, and managerial specialization. The point where the curve reaches its lowest level represents the Minimum Efficient Scale (MES), beyond which the firm fully exploits its productive potential before potentially facing diseconomies of scale.¹

¹ - Tejvan Pettinger, Previous reference.

▪ Pareto efficiency:

Pareto efficiency is a state in which resources are allocated in such a way that it is impossible to improve the well-being of one individual without reducing the well-being of another, reflecting an optimal allocation of resources.

Figure 7: Production Possibility Frontier and Productive Efficiency



Source: Adapted from Investopedia

The graph shows the production possibility frontier (PPF), where the maximum use of available resources is represented by the curve. Point X does not lie on the frontier and therefore indicates inefficiency, as resources are not fully utilized and the economy can increase production of either good.

Points A, B, and C lie on the production possibility frontier and represent efficient outcomes, where all available resources are fully used. At these points, Pareto efficiency is achieved.

Point Y lies outside the frontier and is therefore unattainable with the current level of resources and technology. In order to reach this point, the production possibility frontier must shift outward through an increase in resources or technological progress.¹

¹ - Investopedia Team, "Pareto Efficiency Examples and Production Possibility Frontier," Investopedia, updated March 16, 2026, Retrieved April 15, 2026, from <https://www.investopedia.com/terms/p/pareto-efficiency.asp>.

3. Review of Previous Studies:

Reviewing previous studies is a fundamental pillar of academic research, as it allows for locating the current study within the cumulative scientific framework. This section aims to explore the most prominent academic efforts—nationally and internationally—that have addressed the variables of Digital Transformation and Efficiency. By analyzing these studies, we aim to identify the methodologies used, the geographical and temporal scopes, and the key findings reached, which helps in identifying the "Research Gap" that the current study at GCB intends to bridge.

3.1 National Studies (Algerian Context):

Study 01: Gueraziz, N. (2024)

A doctoral dissertation in Finance and Banking from University of Hassiba Ben Bouali of Chlef titled “**Digital Transformation and its Role in Improving Banking Activity: A Case Study of a Sample of Banks Operating in Algeria and Kuwait**”, examined the extent to which digital transformation affects banking activity in both Algerian and Kuwaiti banks.

The study aimed to identify the impact of adopting digital transformation strategies on the efficiency and quality of banking services by analyzing how digitalization contributes to service development and the reduction of operational costs. It also sought to conduct a comparative field study between the Algerian and Kuwaiti banking sectors in order to identify digital gaps and their effects on banking performance during the period 2019–2023. The researcher adopted a descriptive analytical approach for the theoretical framework and a case study method for the empirical part. Data were collected through questionnaires addressed to managers and employees in the banks under study, in addition to the use of financial and technological indicators for comparison.

The findings revealed that digital transformation significantly improves banking activity by increasing responsiveness to customer needs and enhancing the efficiency of internal operations. The results also showed a clear advantage in favor of Kuwaiti banks in terms of digital maturity due to stronger technological infrastructure and more developed regulatory frameworks. In contrast, the Algerian banking sector still faces organizational and security-related obstacles despite the existing orientation toward the digitalization of banking transactions.

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Study 02: Tikialine, F. (2025)

a doctoral dissertation in Banking and Monetary Studies from University of Ouargla titled “**The Contribution of Digital Transformation to Strengthening Financial Inclusion**”, examined the role of digital transformation in enhancing financial inclusion.

The study aimed to evaluate how digital transformation can serve as a strategic tool for improving financial inclusion levels. It focused on the role of innovative financial technologies in facilitating access to financial services and reducing barriers related to traditional banking systems. The research also analyzed the experiences of Saudi Arabia and Malaysia in order to identify practices that could be applied to the Algerian context during the period 2014–2023. The researcher adopted a descriptive approach to explain the theoretical concepts related to digital transformation and financial inclusion. In the empirical part, the study relied on a comparative case study method through the analysis of digital and financial indicators obtained from official reports and international institutions.

The findings revealed that digital transformation plays a major role in strengthening financial inclusion by reducing transaction costs and overcoming geographical barriers to financial services. The study also showed that Saudi Arabia and Malaysia achieved advanced levels of digital financial inclusion due to the development of digital infrastructure and flexible regulatory frameworks. In the Algerian case, the research highlighted the existence of efforts toward digitalization; however, financial inclusion remains limited because of technical and social challenges, particularly weak network infrastructure and insufficient digital financial culture.

Study 03: Rezkallah, I. M. (2025)

a master’s thesis at the National Higher School of Management (ENSM) titled “**Digital transformation as a lever for operational efficiency: Case Study of SATIM,**” focused on exploring how digital technologies can be mobilized as a lever to optimize internal processes and enhance performance. The study adopted a qualitative approach, relying on semi-structured interviews, participant observation, and document analysis within the SATIM institution. The results confirmed that digital transformation significantly contributes to productivity and service quality by streamlining procedures and reducing operational errors, positioning digitalization as an essential tool for achieving higher levels of operational efficiency in the Algerian electronic payment sector.

Study 04: Ibrahim, S. (2025)

a master’s thesis from the School of Higher Commercial Studies (EHEC) titled “**The impact of Digitalization on the efficiency of the international supply chain: Case Study of CEVITAL Group**” evaluated the role played by digital tools in enhancing the efficiency of logistics operations. The research sought to demonstrate how digitalization offers opportunities to structure processes and achieve speed and cost-effectiveness in international logistics. Using a qualitative methodology based on interviews with key actors at the Cevital Group, the study found that digitalization significantly improves real-time visibility, reduces operational costs

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through automation, and increases the logistical agility required to respond to global market fluctuations.

Study 05: Khentit, K. (2024)

a research article titled "**Digital transformation and its role in improving organizational performance: Case study of Brandt Company**" aimed to identify the impact of digital transformation dimensions—including digital strategy, technological techniques, and organizational culture—on institutional performance. The researcher employed a descriptive-analytical approach, collecting data through a questionnaire distributed to a sample of 50 executives at Brandt. The statistical analysis revealed a strong correlation between these digital dimensions and improved performance, concluding that a successful digital transformation requires total integration between technology and a supportive organizational culture, which acts as the primary driver for change.

Study 06: Benyahia, B., & Guettafi, S. (2025)

published in the Algerian Journal of Public Finance, titled "**The impact of digital transformation on organizational performance: Case study of Algeria Telecommunication, Batna**" analyzed how digital tools influence the performance of service-based public institutions. The study focused on the practical application within the telecommunications sector, concluding that the transition toward digital systems significantly enhances administrative speed and internal coordination, which directly reflects on the overall efficiency of the institution in meeting customer needs.

Study 07: Belhadi, A., et al. (2024)

an article titled "**The impact of digital transformation on the performance of Algerian banks**" explored the role of digitalization from a customer-centric perspective. The research utilized a quantitative approach by distributing questionnaires to bank customers in Saida, Algeria, to assess service quality and ease of access. The findings indicated that digital transformation is a critical factor in enhancing banking performance, as it simplifies procedures and provides innovative access to services, thereby strengthening the competitive advantage of Algerian banks in a modern financial environment

Study 08: Ben Ahmed, F., & Ben Ahmed, N. (2025)

published in the Algerian Journal of Public Finance under the title "**Digital Transformation in Algeria: Reality and Challenges – A Case Study**" aimed to provide a comprehensive analysis of the digital transformation landscape in Algeria. The researchers employed a descriptive-analytical approach to clarify the fundamental concepts of digitalization while highlighting the most prominent stages this sector has undergone. Furthermore, the study utilized an analytical method based on official statistics from the Ministry of Post and Telecommunications to evaluate key digital performance indicators in the country. The findings revealed that despite significant government efforts to prioritize information technology in governance and improve international rankings, the digital sector in Algeria continues to face

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substantial technical and organizational challenges. The study concluded with the necessity of intensifying efforts to develop a robust digital infrastructure to achieve tangible progress and keep pace with global technological developments.

Study 09: Arribi, C., & Boutarfa, S. (2024)

titled "**Digital Transformation: Opportunities and Challenges of Digitization in Algeria**" focused on identifying the strategic opportunities offered by the digital shift for the national economy. The study reviewed various economic indicators and national reports, concluding that while e-governance and digital entrepreneurship offer vast potential, structural challenges related to infrastructure and legal frameworks remain. The authors emphasized the necessity of a holistic national strategy to bridge the existing digital gap and ensure a sustainable transition.

Study 10: Benzaoui and Dahmani (2023)

which is a master's thesis from the University of Mohamed Boudiaf - M'sila titled "**The impact of digital transformation on job performance efficiency**" investigated how the adoption of digital tools affects the productivity of the individual worker within the economic institution. The researchers aimed to evaluate the relationship between digital transition requirements and the quality of functional output. Through a field study, the research found that digitalization significantly reduces the time spent on repetitive administrative tasks, allowing employees to focus on higher-value activities. The study concluded that improving job performance efficiency is closely linked to the institution's ability to provide a developed digital infrastructure and continuous training for its human resources.

3.2 International Studies (The Foreign Context):

Study 11: Al-Malkawi, H. (2024)

published by Cairo University titled "**Digital transformation, development and productivity in developing countries: is AI a curse or a blessing?**" examined the relationship between digital transformation and economic indicators like labor productivity and employment. Using an econometric model (FGLS) on a sample of developing nations, the study answered the fundamental question of AI's impact. The findings proved that digital technology and AI act as a "blessing" by raising productive efficiency and improving employment opportunities, particularly for females, provided that these technologies are harnessed correctly.

Study 12: Vial, G. (2019)

a seminal article titled "**Understanding digital transformation: A review and a research agenda**" established a comprehensive theoretical framework for the field. By reviewing a vast body of literature, the author defined digital transformation as a process that triggers strategic changes to business models through the use of digital technologies. This study serves as a foundational reference for understanding the structural and strategic dimensions of the digital shift in modern organizations.

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Study 13: İnel, M. N. (2019)

titled "**An empirical study on measurement of efficiency of digital transformation using Data Envelopment Analysis (DEA)**" focused on creating an objective metric for digital success. By applying the DEA method to data from the European Commission's Digital Transformation Scoreboard, the study proposed a ranking system for countries based on their efficiency in transforming inputs (like skills and infrastructure) into digital outputs. The results emphasized that e-leadership and a digital entrepreneurial culture are critical enablers for achieving high efficiency in the transformation process.

Study 14: Zhang, T., Shi, Z.-Z., Shi, Y.-R., and Chen, N.-J. (2022)

in their research article titled "**Enterprise Digital Transformation and Production Efficiency: Mechanism Analysis and Empirical Research**" examined the impact of digital transformation on production efficiency within enterprises. The study adopted an empirical quantitative approach using Stochastic Frontier Analysis (SFA) on a large sample of enterprises. The researchers aimed to analyze how digital transformation contributes to improving productivity and optimizing resource allocation.

The findings revealed that digital transformation significantly enhances production efficiency by reducing information asymmetry improving innovation capacity and facilitating resource management within enterprises .

Chapter One: The theoretical framework of digital transformation and Efficiency

Summary of Chapter One:

Based on this chapter, we can conclude that Digital Transformation is a key factor in modernizing companies and improving their performance. It is a powerful tool for creating new ways of working and achieving growth by using digital technologies in all parts of the business. This chapter shows that digital transformation is not just about technology, but it is a major change that improves the overall Efficiency of the organization.

Digital transformation is important because it helps the company use its resources better, reduce costs, and make faster decisions. There is a strong connection between digital transformation and efficiency; in fact, efficiency is the main way to measure if digitalization is successful. We also found that this change depends on several factors, especially the quality of technology and how well the people in the company can adapt to it.

Finally, the ideas discussed in this chapter provide the basis for the practical part of this research. This study helps us understand how to use digital tools to meet the specific needs of the National Company for Civil Engineering and Construction (GCB), aiming to connect global digital trends with the real situation in the Algerian industrial sector

Chapter Tow:

Empirical Study of the Impact of Digital
Transformation on Efficiency – Case Study of
GCB in Boumerdes

Chapter Tow :Empirical Study of the Impact of Digital Transformation on Efficiency – Case Study of GCB in Boumerdes

Preface:

The study of digital transformation has become essential due to its significant role in improving the efficiency of economic institutions and enhancing their performance. In this context, analyzing its practical impact is necessary to understand how modern technologies contribute to achieving better results in real organizational settings.

Accordingly, this chapter is devoted to the empirical analysis of the impact of digital transformation on efficiency within the economic institution under study. It aims to provide a practical application of the theoretical concepts discussed in the previous chapter. Through this chapter, the following points will be addressed:

- 1) Presentation of the Host Institution (GCB in Boumerdes): An overview of the company's structure, activities, and its role in the national economy.**
- 2) Research Methodology: A detailed description of the descriptive approach and the qualitative tools used for data collection.**
- 3) Digital Transformation Practices in GCB: An analysis of how digital systems are integrated and utilized within the different departments.**
- 4) Discussion of Findings: An evaluation of the impact of these practices on efficiency, including the testing of hypotheses and the final results of the study.**

Chapter Tow :Empirical Study of the Impact of Digital Transformation on Efficiency – Case Study of GCB in Boumerdes

1. Presentation of the host institution (GCB in Boumerdes):

This section provides a presentation of the host institution (GCB). It includes a general overview of the company, its organizational structure, and its main activities.

1.1.General Overview:

The National Company of Civil Engineering and Building (GCB) is a joint-stock company operating in the field of civil engineering, construction, and oil & gas infrastructure. It is a subsidiary of the Sonatrach Group and plays a strategic role in supporting national economic development.

GCB was established following the restructuring of Sonatrach by Decree No. 81.173 and was later transformed into a joint-stock company on July 12, 1998. With more than 40 years of experience, the company has progressively developed its capabilities and strengthened its position in the engineering and construction sector.

The company operates across the entire national territory and has built a solid reputation through its achievements in large-scale infrastructure and industrial projects, particularly in the oil and gas sector. Its strategic orientation focuses on engineering, project management, and the development of energy-related activities.

From a legal and financial perspective, GCB is structured as a joint-stock company (SPA) with a share capital of 40,000,000,000 DZD, fully owned by the Sonatrach Group. The company's headquarters is located in Boumerdes, Algeria.

GCB possesses significant human and material resources that enhance its operational capacity. The company employs more than 22,000 workers, distributed across different socio-professional categories, ensuring a high level of expertise and adaptability. In addition, GCB owns a large fleet of more than 4,900 equipment units, including over 3,500 heavy and strategic machines, which enable the company to ensure operational autonomy and efficient project execution.

The company is also characterized by its strong production capacity and technical capabilities. For example, it has completed more than 2,000 km of pipelines over the past five years, demonstrating its expertise in large-scale industrial projects. Furthermore, GCB integrates an Integrated Management System (IMS) aligned with international standards such as ISO 9001, ISO 14001, and ISO 45001, reflecting its commitment to quality, safety, and environmental protection. Overall, GCB represents a major industrial actor in Algeria, combining extensive experience, strong resources, and advanced technical capabilities, which enable it to contribute effectively to national infrastructure development and the energy sector.

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1.2.Organizational Structure:

GCB adopts a hierarchical and structured organizational framework designed to ensure effective coordination and efficient management of its activities across the national territory. The company's organization is based on three main levels: the strategic level the managerial level, and the operational level.

At the top of the hierarchy is the General Management, located in Boumerdes, which is responsible for defining the company's strategic orientations and supervising overall operations. At the managerial level, several central directorates support decision-making and ensure the proper functioning of the company. These include the Engineering and Procurement Directorate, Equipment Directorate, Purchasing Directorate, General Means Directorate, Railways and Structures Directorate, Water Treatment Directorate, and Steel Construction Directorate. At the operational level, GCB relies on a decentralized structure composed of regional and specialized directorates distributed across different regions of Algeria. These include the Central Region Directorate (Boumerdes), Western Region Directorate (Arzew), South-East Directorate (Hassi Messaoud), South-West Directorate (Hassi R'mel), Southern Directorate (In Amenas), as well as specialized units such as the Pipeline Works Directorate and the Mechanical Assembly and Maintenance Directorate.

This organizational structure reflects a high level of specialization and decentralization, which enhances coordination, improves operational efficiency, and enables the company to effectively manage large-scale and complex projects.³¹

Figure 8:Organizational Structure of GCB



Source: Prepared by the student based on company documents

³¹ -National Company for Civil Engineering and Construction (GCB). *Official Website*. Retrieved April 10, 2026, from <https://www.gcb.dz>

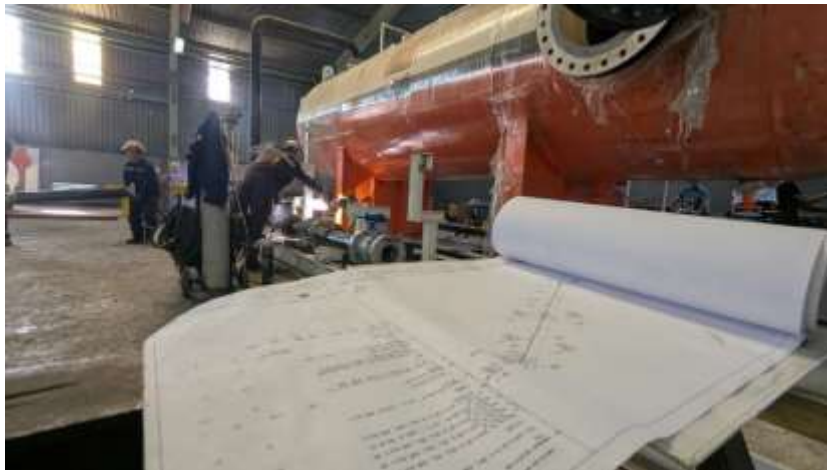
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1.3.Main Activities:

▪ **Engineering & Procurement :**

GCB's Engineering and Procurement (E&P) department represents the technical backbone of the company's industrial projects. With a significant production capacity of 700,000 man-hours per year, the company relies on a highly qualified engineering team and advanced design tools to deliver innovative solutions from conception to execution .The department's expertise spans two key sectors: Oil and Gas Engineering, which includes pipeline engineering, pumping stations, and Front-End Engineering Design (FEED); and Construction Engineering, covering civil engineering, steel structures, and large-scale infrastructure such as desalination plants Furthermore , GCB ensures the efficient operation of industrial facilities through a robust procurement system and professional project management, guaranteeing that all required components are acquired and integrated with a high level of technical excellence.³²

Figure 9: GCB Engineering & Procurement



Source: GCB Official Website ([gcb.dz](https://www.gcb.dz)), Gallery

³² -National Company for Civil Engineering and Construction (GCB). *Official Website*. Retrieved April 10, 2026, from <https://www.gcb.dz>.

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▪ Pipeline :

GCB is recognized as a leading company in the construction of large-diameter strategic pipelines for the transportation of oil, gas, and water. With a significant production capacity of 200 km per year and more than 40 years of field experience, the company oversees all stages of pipeline infrastructure development.

This includes right-of-way clearing, specialized trenching, cold pipe bending, high-precision welding, and rigorous hydrostatic testing to ensure safety and durability. GCB has successfully completed major national projects, including the GR7 (311 km) and GR5 (154 km) gas pipelines, as well as the OK1 (126 km) oil pipeline. By integrating professional project management with advanced technical expertise, GCB continues to ensure the reliable transportation of energy and water resources across the country.³³

Figure 10:Field Operations and Infrastructure Deployment for the Pipeline Activity



Source: GCB Official Website ([gcb.dz](https://www.gcb.dz)), Gallery

³³ - National Company for Civil Engineering and Construction (GCB). *Official Website*. Retrieved April 10, 2026, from <https://www.gcb.dz>.

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■ Hydraulic Works:

GCB has strategically diversified its activities into the water resources and treatment sector to meet the increasing national demand for water security. The company has positioned itself as a key player by providing integrated solutions covering both the design and construction of specialized infrastructure. Its core services include seawater desalination plants using advanced technologies, wastewater treatment facilities for safe reuse, and comprehensive pumping and water treatment systems for potable water supply. In addition, GCB undertakes the construction of large-capacity strategic reservoirs and extensive water transfer pipelines. Notable projects include the Corso Desalination Plant in Boumerdes (80,000 m³/day) and the Cap Blanc Plant in Oran (300,000 m³/day), reflecting the company's strong commitment to sustainable development and environmental protection.³⁴

Figure 11:Hydraulic Systems: From Water Transfer Pipelines to Storage Reservoirs



Source: GCB Official Website ([gcb.dz](https://www.gcb.dz)), Gallery

³⁴ -National Company for Civil Engineering and Construction (GCB). *Official Website*. Retrieved April 10, 2026, from <https://www.gcb.dz>

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▪ Oil and Gas Equipment Manufacturing:

GCB has established itself as a significant contributor to the local manufacturing of mechanical equipment for the oil and gas sector. Supported by its parent company, SONATRACH, this strategic initiative aims to strengthen national industrial production, reduce dependence on imports, and create employment opportunities. Through this activity, GCB contributes to enhancing industrial sovereignty by providing locally manufactured solutions that meet the requirements of Algeria's energy infrastructure. The company produces a wide range of specialized equipment, including pig launcher and receiver stations, separators, filtration units, chemical injection systems, manifolds, and heat exchangers. By complying with international standards and relying on strategic partnerships, GCB ensures the development of innovative technological solutions capable of addressing the operational needs of the national oil and gas industry.³⁵

Figure 12:Oil and Gas Equipment Manufacturing Activity at GCB



Source: GCB Official Website (gcb.dz), Gallery

³⁵ -National Company for Civil Engineering and Construction (GCB). *Official Website*. Retrieved April 10, 2026, from <https://www.gcb.dz>.

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In addition to the previously discussed sectors, GCB's operational portfolio extends to several other strategic industrial activities. These areas reflect the company's commitment to diversification and its ability to manage complex, multi-disciplinary infrastructure projects. The following sections present an overview of the remaining core activities that contribute to GCB's comprehensive industrial role:

- Industrial Civil Engineering for Large Oil and Gas Installations.
- Railway Infrastructure and Structural Works.
- Industrial Assembly and Operations.
- Roads, Highways, and Aerodrome Construction.
- Metal Construction and Boiler making.
- Buildings and Utility Infrastructure.
- Prefabricated Construction Systems.

2. Research Methodology:

This section presents the methodology used in this study to examine the impact of digital transformation on efficiency within GCB. It explains the research approach, the case study method, and the data collection techniques used. In order to better understand how digital transformation is applied within the company, this study relies on direct observation and semi-structured interviews conducted during the internship period. These methods helped in collecting practical information from different departments within the organization. This methodological approach makes it possible to describe how digital transformation is implemented and to understand its role in improving efficiency.

2.1.Research Approach:

The present study adopts a descriptive research approach supported by a case study method to examine the impact of digital transformation on efficiency within GCB. The descriptive approach is appropriate for analyzing real organizational phenomena as they occur in practice, particularly the adoption of digital technologies and their effects on efficiency, communication, and overall organizational performance. It allows the researcher to observe the current state of digital transformation within the company and describe its contribution to improving different types of efficiency.

In addition, the study relies on the case study method, focusing on GCB as a representative example of a large Algerian public industrial company undergoing modernization and digital development. This method is suitable because it enables an in-depth understanding of the organizational context in which digital transformation takes place. By concentrating

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on a single organization, the researcher can examine internal practices, management systems, technological tools, and organizational changes in detail.

The choice of GCB as a case study is justified by several factors. First, the company occupies a strategic position in Algeria's industrial and construction sectors and manages large-scale projects that require high levels of coordination and control. Second, GCB has progressively adopted modern technological solutions aimed at improving performance and ensuring continuous development. Third, the researcher had direct access to the company through an internship period, which provided the opportunity to observe internal processes and interact with employees across different departments.

Therefore, combining the descriptive approach with the case study method provides an appropriate framework for understanding how digital transformation is implemented within GCB and how it contributes to improving efficiency in a real organizational environment.

2.2.Data Collection Methods:

To collect the necessary data for this empirical study I relied on qualitative data collection methods. This choice aligns with the descriptive nature of the research, which aims to understand the study within its natural context by gathering detailed data directly from the participants and their environment. The data were collected during my internship at GCB using two primary tools: Direct Observation and Semi-Structured Interviews.

▪ Direct Observation:

Direct observation is defined as a qualitative data collection method that involves systematically watching people, activities, and interactions within their natural setting to understand how processes occur in reality ^{.36}. During my internship at GCB, I used this method to follow the daily activities performed by workers within the institution and to understand their work mechanisms. I observed how employees perform their tasks, the extent to which digital tools are utilized, and how information is exchanged between departments. Through this tool, I was able to collect reliable notes and data based on the actual practices I witnessed firsthand.

³⁶ - Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications, p. 239, Retrieved April 19, 2026, from <https://fliphtml5.com/gudqi/sxgk/>.

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▪ **Semi-Structured Interviews:**

Semi-structured interviews are a qualitative tool that combines a predefined set of questions with a flexible and open discussion, allowing the researcher to explore participants' responses in depth ³⁷.

In this study, I conducted interviews with employees from various departments within GCB: the Finance Department, IT and Programming, Human Resources, and Communication Department, I prepared a set of guiding questions for the interviews focusing on how tasks are accomplished using digital tools. This method enabled me to collect accurate information tailored to the specific experience of each participant in the interviews I conducted.

2.3.Study Participants:

The study participants consist of a purposive sample of employees working at the National Company for Civil Engineering and Construction (GCB). To obtain accurate and diverse information regarding the use and impact of digital transformation on organizational efficiency, participants were selected from different departments: Finance (Treasury), Information Technology and Programming, Human Resources (HR), and the Communication Department.

The participants included:

- The Head of the Treasury Department.
- A State Engineer in Computer Science.
- An employee from the Human Resources Department.
- An employee from the Communication Department.

These participants were selected because their daily tasks are directly linked to the use of digital tools and information management within the organization.

2.4.Research Variables:

To analyze the impact of digital transformation on efficiency within GCB, the research focuses on two main types of variables:

-Independent Variable (Digital Transformation): This includes the digital tools software, and information systems used in the different departments (Finance, IT, HR, and Communication).

-Dependent Variable (Efficiency): This refers to the improvement in work performance, speed of task completion, reduction of errors, and the optimization of human and financial resources.

³⁷ - Creswell, Previous reference.

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2.5.Data Analysis Method:

After collecting the data through direct observation and semi-structured interviews, the information obtained was analyzed using a qualitative descriptive approach. This method was considered appropriate because the study is based on qualitative data collected from employees working in different departments within GCB.

To facilitate the analysis process, I first prepared different interview questions adapted to each department involved in the study, namely Finance, Information Technology and Programming, and Human Resources. The questions focused mainly on work practices, the use of digital tools, communication methods, and the organization of daily activities within the company.

After conducting the interviews, I carefully reviewed the collected responses and organized the information according to recurring ideas and common themes identified during the discussions. The responses were classified into several categories related to digital tools, communication, work organization, and efficiency in order to facilitate the interpretation of the data.

In addition, I compared the responses provided by employees from different departments to identify similarities and differences in their experiences and perceptions regarding digital practices within the company. This comparison helped provide a broader understanding of how digital transformation is integrated into different organizational functions. The analysis process was also supported by the observations collected during my internship period. The information obtained through direct observation helped confirm and complement several points mentioned during the interviews, which contributed to increasing the credibility and consistency of the collected data.

Finally, the analyzed information was interpreted in relation to the objectives of the study in order to better understand the reality of digital transformation practices within GCB and their relationship with efficiency.

3. Digital Transformation Practices in GCB:

This section presents the empirical results of the study conducted at the National Company for Civil Engineering and Construction (GCB). Following the qualitative descriptive approach, the objective is to display the information gathered through direct observation and semi-structured interviews. This chapter is divided into two main requirements: the first requirement provides a detailed presentation of the data from the four targeted departments, while the second requirement focuses on discussing and interpreting these findings in relation to organizational efficiency.

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3.1.Presentation of Results:

In this requirement, the data collected from each department is presented. For each section, the results of the semi-structured interviews (Questions and Answers) are provided first, followed by the descriptive notes derived from direct observation.

3.1.1. Results of the Information Technology (IT) and Programming Department:

▪ Interview Data:

To gain an in-depth understanding of digital practices from the perspective of the organization's managers and technicians, and to assess the impact of digital transformation on improving efficiency within the National Company for Civil Engineering and Construction (GCB) - Boumerdes Unit -, a field interview was conducted with Mr. Baka Abdeladim, who serves as a State Engineer in Computer Science and Programming. The interview took place on April 26, 2026, at the company's headquarters. The questions focused on the technical and operational dimensions related to digitalization. Below is a presentation of the questions raised during this interview along with the responses:

Table 1:Efficiency Indicators and Interview Responses - IT Department

Efficiency Indicator	Question	Answer
Regarding time efficiency	how have the systems been configured to reduce the time between receiving a request and its execution? Is time tracked automatically?	The systems have been configured to operate through streamlined digital workflows that eliminate the need for the physical movement of documents. Task execution time is tracked automatically in some core systems to ensure rapid responsiveness. Requests are immediately routed to the relevant department, significantly reducing the waiting periods previously caused by paper-based bureaucracy.

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Real-time Operations	What are the operations that have shifted from "manual" to "real-time" thanks to the system?	There has been a radical transformation in several processes, most notably: Digital Recruitment System: Previously, candidates submitted their CVs in hard copy at the security office, and they were then moved manually between offices. Now, candidates scan a QR Code at the entrance to access the company's website (GCB.dz) and upload their files directly. The system automatically categorizes files by specialty and department, making the information instantly available to the concerned authority. Equipment Tracking System: An internal platform has been provided to monitor the status and maintenance of equipment from the moment of purchase, facilitating immediate and highly accurate cost calculation and reduction.
Resource Allocation Accuracy	How does the digital data provided by the system contribute to making resource allocation more accurate?	Digital data provides a comprehensive and real-time view of available resources (human and material). Through the equipment and project tracking system, resources can be allocated based on the actual needs of each field workshop, preventing equipment accumulation at one site while depriving another, which is the essence of efficiency in resource utilization.

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Operational Automation	Are there systems that have reduced manual intervention in GCB's operational processes?	Yes, the company currently relies on various internal platforms and websites that have automated several workflows. Many reports that previously required manual collection and human auditing are now generated automatically from databases, reducing human intervention and the potential for errors.
Proactive Error Detection	Does the system provide automated reports for error detection and resolution before they occur?	Currently, some vital systems provide alerts when discrepancies are found in the entered data. While comprehensive proactive error detection is not yet fully implemented across all systems, we are working within our current strategy to add this feature as a core technical requirement to ensure data integrity.
Data Quality Assurance	How does the system ensure the quality of final reports submitted to top management?	The system ensures this through the use of Standardized Templates. The software does not accept incomplete or non-compliant data, ensuring that the reports submitted to top management are highly reliable and accurate, making them easier to read and analyze.
Data Integration	Is there a unified database that supports rapid decision-making across all departments?	Yes, integrated databases are available, categorized by department and function. This integration allows each department to access the information needed for fast and accurate decision-making, such as the equipment tracking system which provides financial and technical data serving both the Finance and Projects departments simultaneously.

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Data Processing Speed	From a technical perspective, how do you compare the speed of data processing before and after digital transformation?	Technically there is no comparison digital transformation has made operations exponentially faster Data processing that used to take days in manual archiving and sorting is now completed in fractions of a second increasing the overall productivity of the institution
Performance Indicators (KPIs)	Are there digital Key Performance Indicators (KPIs) programmed within the system to measure performance quality periodically?	Currently there are no automatically programmed KPIs for periodic performance measurement but work is underway to develop this feature as part of future dashboards.
Procedural Efficiency	Has the number of procedural/programming steps required to issue a field project report decreased?	Yes, certainly Procedural paths have been significantly shortened Instead of multiple paper-based stages the system can now capture data directly from the field and generate reports in just a few technical steps.
Decision Support Tools	What digital tools (Dashboards) have you provided to management to increase decision accuracy?	We have developed digital interfaces that display statistical summaries of project and equipment status. These tools allow managers to view the general status of the institution through simple and focused Dashboards, increasing the accuracy of strategic decisions.
Asset Utilization Tracking	Do you provide tracking programs for the company's equipment to ensure its optimal utilization?	Yes, there is a specialized system for tracking the lifecycle of equipment, which helps in scheduling periodic maintenance and tracking its location, ensuring optimal use of assets and reducing downtime.

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Progressive Efficiency Improvement	Do you believe, from a technical standpoint, that efficiency has improved radically or gradually?	The improvement is taking place in a "studied gradual manner." We rely on adding and developing digital technologies sequentially to ensure system stability and better employee adaptation.
Data Redundancy Reduction	How has digitalization contributed to reducing "technical waste" in redundant data processing efforts?	Digitalization has eliminated Data Redundancy (re-entering the same information in multiple offices). Information is entered once into the centralized database and is utilized by all relevant parties, saving significant effort previously wasted on manual repetition.
Operational Leap/Impact	What technical feature has brought about the biggest leap in the organization's performance?	There are many features, but field project tracking systems represent the biggest leap, as they link central management to the reality of the workshops in real-time.
Implementation Strategy	How was digital transformation actually introduced within the institution? In which areas did it start first?	Digital transformation began by identifying the processes most consuming of time and effort. The actual start was in administrative and financial areas to establish control, then expanded to include operational aspects, recruitment, and equipment tracking.
Requirements Analysis Challenges	Are there any technical problems that might affect the work?	Yes, we face some technical challenges such as fluctuations in internet quality, especially in remote sites, in addition to the continuous need to upgrade the infrastructure to keep pace with modern software.

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Requirements Analysis Challenges	What are the most prominent difficulties you faced during the implementation of digital transformation?	The greatest difficulty lies in the "Requirements Analysis" phase. Before building any digital solution, we must deeply understand the problem and receive comprehensive information and clear visions from the party requesting the solution. The communication gap in understanding precise technical requirements is the most prominent challenge we strive to overcome to ensure the construction of systems that achieve the desired goals.
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Source: Prepared by the student

▪ **Observation data :**

During my internship at GCB, I followed the work process in the IT department to see how digital systems work in reality. I noticed that the department is the heart of the company's operations. I saw how the digital recruitment and equipment tracking systems work smoothly without using any paper. The data moves quickly from one stage to another, which proves that the company has successfully replaced old manual methods with fast digital tools. This clearly helps in saving time and reducing errors in daily tasks.

3.1.2. Results of the Communication Department:

▪ **Interview Data:**

To evaluate how digital transformation has improved the efficiency of information flow and organizational image, an interview was conducted with Mr. Chicouche Lotfi, who holds the position of Communication Specialist at GCB. The interview took place on May 4, 2026, at the company's headquarters. The discussion focused on the shift from traditional communication to digital platforms and its impact on institutional efficiency. Below is a presentation of the questions raised during this interview along with the responses:

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Table 2:Efficiency Indicators and Interview Responses - Communication Department

Efficiency Indicator	Question	Answer
Information Flow Speed	How has the transition to digital internal platforms reduced the time required to circulate administrative memos?	The transition has been transformative memos that took days via mail now reach remote units in seconds ensuring everyone is aligned instantly.
Coordination Efficiency	To what extent have digital tools improved the coordination between headquarters and remote project sites?	Digital tools have virtually eliminated the distance gap allowing for real-time reporting from field sites which was nearly impossible before.
Digital Image Management	How does the company leverage its website and social media to maintain a professional image?	We use our website and social media as a digital storefront to showcase achievements and maintain transparency with partners and the public.
Paperwork and Cost Reduction	Has the adoption of digital communication significantly reduced printing costs and physical archiving space?	Yes, the reduction is significant we have cut printing costs and retrieving a document now takes a few clicks instead of hours of manual searching.
Information Accuracy	How does digitalization ensure that information reaches all employees without distortions?	Digitalization acts as a single source of truth delivering announcements in their original form and eliminating the risk of information distortion.
Feedback and Interaction	What digital mechanisms are used to receive and process employee feedback?	We use digital surveys and feedback forms which allow us to analyze concerns statistically and respond much faster than traditional methods.
Crisis Communication	How do digital channels help the department manage communication efficiently during emergencies?	Speed is everything in emergencies digital channels allow us to release urgent fact sheets immediately to prevent the spread of rumors.

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Media Archiving Efficiency	How has the process of searching for and retrieving media files changed with digital archiving?	We moved to a centralized Digital Asset Management system making the search for project photos or videos 90% faster using keywords.
Standardization of Communication	How have digital templates improved the quality and consistency of the company's reports?	Digital templates ensure that every document follows GCB's visual identity which reinforces our brand and saves time spent on formatting.
Impact on Productivity	Has the move toward a paperless environment increased the overall daily productivity of your team?	Absolutely the paperless environment has streamlined daily tasks allowing the team to focus on strategic planning instead of logistics.
Digital Challenges and Risks	What are the most prominent technical challenges or obstacles you face such as hacking or fake pages?	We face security risks like hacking attempts and fake social media pages along with unstable internet in remote areas and the need for constant hardware upgrades.

Source: Prepared by the student

■ **Observation data :**

During my presence at GCB I closely observed the daily operations within the communication department I noticed a clear shift toward digital tools where professional email and internal networks have replaced traditional paper memos. A key observation was the heavy reliance on office hardware such as computers and digital screens to manage and display information with a noticeable absence of paper files on desks I also monitored how the team manages the company's official social media platforms to provide real-time updates while the efficiency is high I observed that the department stays alert to security challenges like fake pages It is evident that digitalization has not only speeded up the information flow but also modernized the company's internal work environment.

3.1.3. Results of the Human Resources (HR) Department:

■ **Interview Data:**

To understand how digital transformation affects employee performance and management an interview was conducted with Mr. Rochdi Mouzaoui He is a specialist in the Human Resources Department at GCB. The interview took place on April 24, 2026. The goal was to discuss how digital tools help in managing staff saving time and improving overall work efficiency Below is a presentation of the questions raised during this interview along with the responses:

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Table 3:Efficiency Indicators and Interview Responses - Human Resources Department

Efficiency Indicator	Question	Answer
Hardware Reliability	Are current digital tools (hardware and software) easy to use without technical complications?	The software is good but the hardware is a big problem Computers are old and slow I often use my personal laptop to finish my work on time.
Digital Readiness	Is the organizational environment at GCB ready for a 100% digital transformation?	The environment is in a transition stage It is not 100% digital yet because many documents still must be printed and signed by hand.
Technical Support	Is there enough technical support internet speed PC quality in all offices and sites?	Support is available, but internet speed in remote areas is weak, and hardware needs a major upgrade to support the digital shift.
Skill-Software Fit	Does the software quality match the current skill levels of all employees?	The software is simple, but it is not enough for everyone. The gap is not in the software itself but in the equipment used to run it
Digital Awareness	Is there enough digital awareness among staff or is there resistance to change?	Awareness is growing, but there is still resistance from older employees. They prefer paper because they feel it is safer and more reliable than digital files
Time Efficiency	Have you noticed an increase in the number of tasks finished in less time?	Efficiency has improved slightly, but the need to print digital files for manual signatures wastes some of the time we saved.
Effort Reduction	Has the physical and mental effort of repetitive tasks been reduced?	The mental effort is less when using software, but the "double work" (doing it on the screen then printing it) is still tiring.
Task Fairness	How did digital tools help in distributing tasks fairly among workers?	The tools help us see who is working, but since the system is not fully digital it is hard to achieve perfect fairness in distribution

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Productivity Metrics	What metrics do you use to measure worker productivity (like response speed)?	We don't have a specialized digital system for metrics yet we still depend on personal observation and traditional reports to measure productivity.
Process Smoothness	Have administrative cycles (requests/permits) become fully smooth and digital?	Procedures are better but not fully smooth many digital requests still require a physical paper trail for official validation.
Change Resistance	Is low hardware quality a reason why some employees prefer old paper methods?	Yes, slow computers make some employees frustrated so they go back to paper methods because they find them more guaranteed.
Innovation Space	Does the digital system allow employees to suggest ideas for development?	The system is still a bit rigid. It is mostly for execution, and there is limited space for digital suggestions from employees.
Self-Learning	Does the company provide a digital environment for self-learning?	Self-learning is mostly personal effort. There is no official digital learning platform within the company yet.
Performance Tracking	Do digital tools allow management to track and reward "efficient employees" automatically?	No, there are no digital tools to track performance yet. We cannot reward employees based on digital data because the system is not yet designed for that.
System Sustainability	Is the current environment ready for more complex digital updates in the future?	The current environment needs more work on infrastructure and culture before it can accept more complex digital systems.
Process Speed	What is the difference in speed and quality between traditional and digital stages?	Digital work is faster in data entry, but the traditional stage is still present in the "final signature" and archiving of paper
Staff Adaptation	Were employees retrained after the introduction of digital systems?	Some training was provided, but we need more sessions, especially for older staff to help them adapt to the new screens.

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System Evolution	How was the workflow before digitalization compared to the current situation?	Before it was a "paper desert" Now we are in a "hybrid environment" a mix of modern software and old paper habits. We are moving forward but the journey is not finished
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Source: Prepared by the student

▪ **Observation data:**

During my internship at the Human Resources Department of GCB I observed a work environment characterized by a hybrid overlap between digital and traditional systems Although specialized software is available for personnel management reliance on paper remains the dominant rule in daily operations I witnessed a significant volume of physical records and paper files occupying much of the office space serving as the primary official reference for decision making or reviewing employee records Furthermore I noticed that employees often perform double work tasks begin with digital data entry but must conclude with printing and manual signatures to achieve legal validity This persistent reliance on paper is not only due to the absence of electronic signatures but is also rooted in the prevailing organizational culture which still views paper as a safer and more reliable medium for archiving and quick access especially given the technical lag and hardware performance issues observed.

3.1.4. Results of the Finance and Accounting Department:

▪ **Interview Data:**

To evaluate the impact of digital transformation on financial performance, an interview was conducted with Ms. Nassima Tazerouti, the Chief of Treasury Service at GCB. The interview took place on April 24, 2026. The discussion focused on how digital tools and financial platforms contribute to time efficiency, error reduction, and strategic decision-making within the treasury. The following sections present the questions, indicators, and responses from this interview:

Table 4:Efficiency Indicators and Interview Responses - Finance and Accounting Department

Efficiency Indicator	Question	Answer
Time Efficiency	How has digital transformation affected the duration of daily operations within the institution?	There is a positive shift regarding sending files and information within the required time which leads to making the right decisions.
Specialized System Effectiveness	Are there specific operations that have become instant or faster thanks to digital systems? (Please provide an example)	Definitely this is evident in banking applications and tax services such as EDI, JIBAYATIC, and BIG FINANCIER.

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Response and Execution Time	Has the time between receiving a request and its execution been reduced after digitalization?	Yes especially in financial files related to the treasury to avoid financial fines and penalties resulting from delays.
Productivity Efficiency	Has the volume of work completed during the same period increased after the digital shift?	Not necessarily; the real profitability and value of digital transformation appear clearly during Information Pressure or heavy workloads.
Task Capacity and Project Management	Have digital tools contributed to an increase in the number of executed projects or tasks?	It made it easier to acquire a larger number of projects which naturally increased the associated tasks.
Resource Efficiency	Has digital transformation helped reduce the waste of resources (paper time effort)?	Of course digital transformation directly impacted saving time reducing errors and decreasing the use of office supplies (paper)
Resource Distribution Accuracy	Has the distribution of resources within the institution become more accurate and effective?	Yes it has become more accurate since digital applications help in monitoring data and information, improving the entire Information System.
Operational Efficiency	Are errors discovered and corrected faster than before?	Generally, errors are discovered automatically by the digital applications, which increases operational effectiveness.
Quality Efficiency	Has the quality of final outputs (reports, projects) improved after digitalization?	Work outputs have become faster and more efficient than before.
Error Mitigation and Accuracy	Has digital transformation contributed to reducing errors in work?	Certainly, digital systems ensure much higher accuracy.
Human Efficiency	Has digital transformation helped raise the efficiency of employees in performing their tasks?	Yes, there is a noticeable improvement in the efficiency of employee performance

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Decision-Making Efficiency	Have administrative decisions become faster thanks to the availability of digital data?	Yes, digitalization has improved the speed and quality of decisions taken.
Informational Reliance	Does the management rely on digital reports to make decisions?	Absolutely. Strategic decisions are only made based on accurate digital data and reports.
Strategic Decision Accuracy	Has digital transformation helped improve the accuracy of decisions and reduce mistakes?	Yes, it has directly helped in improving financial decisions and their accuracy.
Overall Efficiency Comparison	How do you compare the level of efficiency before and after implementing digital transformation?	The level of efficiency after digitalization lies in saving time and making the most correct and accurate decisions.

Source: Prepared by the student

▪ **Observation data:**

In the Finance Department, I saw that the work is very digital. The employees are very focused on deadlines (times) because they use systems like DGI and EDI to avoid fines. I noticed they use very little paper inside the office. The most important thing I saw is that the software helps them find mistakes in numbers immediately. The office is very organized, and it is clear that they depend on digital tools to manage the company's money accurately.

4. Discussion of Findings:

After presenting the data collected from the various departments at GCB, this section aims to discuss these findings in detail. The purpose is to understand how digital transformation actually impacts the company's efficiency in the field. This discussion will connect the practical results with the theoretical framework, followed by a comparison with previous studies and the presentation of final recommendations to improve the company's performance.

4.1 Discussion of Results by Department:

4.1.1 IT Department:

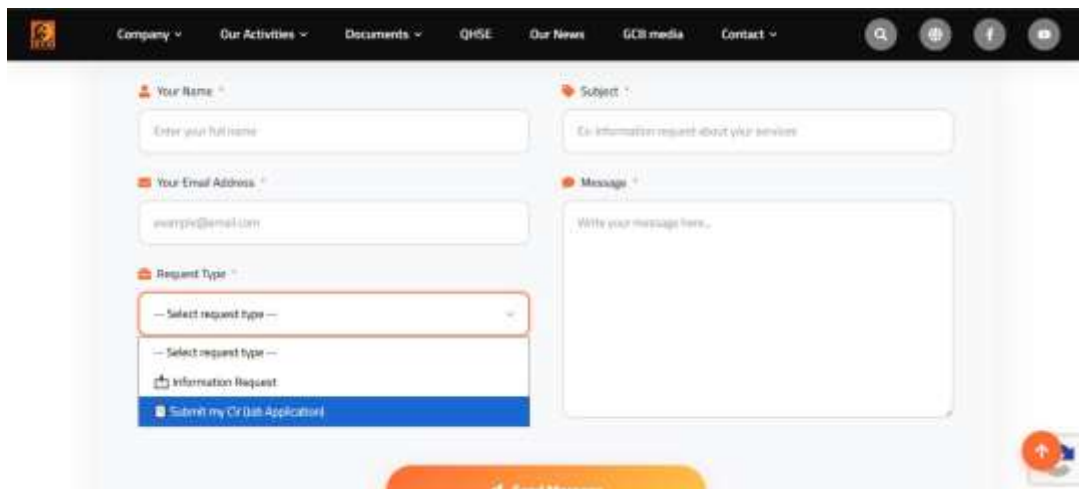
The discussion of the IT department's results reveals a high level of digital maturity through the implementation of specialized platforms that directly enhance institutional efficiency.

The Recruitment and Information Portal (QR Code System):

One of the most significant findings is the digital recruitment system. By scanning a QR code at the company's entrance, job seekers can access a dedicated website to upload their CVs and personal data at any time. This system has transformed the recruitment process for both the company and the candidates.

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Figure 13:User Interface for CV Upload on the GCB Official Website

The image shows a web form for CV upload on the GCB Official Website. The form is titled 'CV Upload' and includes fields for 'Your Name', 'Your Email Address', 'Subject', and 'Message'. There is a 'Request Type' dropdown menu with options like 'Information Request' and 'Submit my CV Data Application'. A 'Send Message' button is at the bottom right.

Source :Prepared by the student based on the official GCB website: <https://www.gcb.dz>

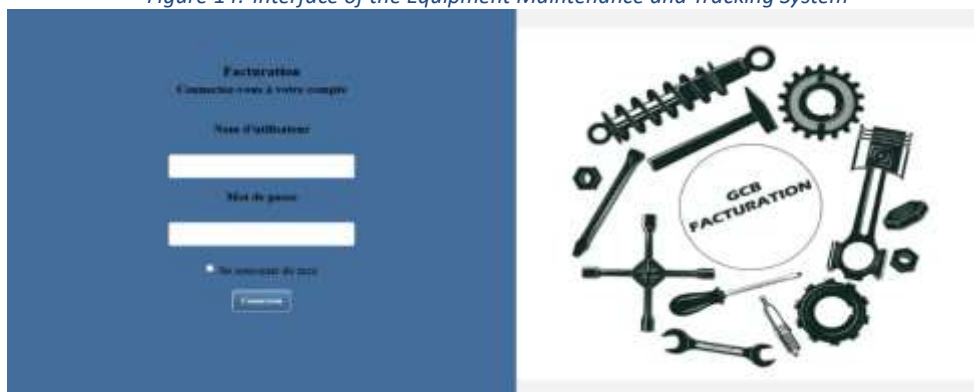
Impact on Efficiency: Previously, sorting paper files was a long manual process. Now the website automatically organizes applications by specialty and directs them to the relevant departments. This transition has led to a major reduction in manual effort and a significant gain in time, allowing the administration to focus on selecting the best talent rather than managing paperwork. Furthermore, the site serves as a central information hub for students and researchers, making general data about GCB more accessible.

The Equipment Maintenance and Tracking System:

The second vital tool is the digital platform for equipment monitoring. Before this system, it was nearly impossible to accurately track the maintenance history, downtime, or total repair costs of machinery.

Impact on Efficiency: With this digital system, monitoring is now organized and integrated. The company can identify machines that break down frequently and decide whether to sell them, use them for spare parts, or replace them. The most important result is the ability to calculate total costs and manage all invoices precisely. This has led to a direct reduction in maintenance expenses and better resource management.

Figure 14: Interface of the Equipment Maintenance and Tracking System

The image shows the interface of the Equipment Maintenance and Tracking System. It features a blue background with a white form titled 'Facturation' (Facturation: Collecte des données et suivi des équipements). The form includes fields for 'Nom de l'équipement' and 'Valeur de l'équipement'. Below the form is a 'Facturation' button. To the right of the form is a circular graphic with the text 'GCB FACTURATION' and various mechanical parts like gears, bolts, and a wrench.

Source: GCB Prepared by the researcher based on internal company data provided by the IT Department (2026)

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Conclusion for this Department:

The digital transformation in the IT department has moved beyond basic technical support to becoming a strategic tool for optimization. The results clearly show that by replacing manual tasks with automated digital systems, GCB has achieved a higher level of operational and financial efficiency, characterized by faster processing times and better cost control.

4.1.2 Communication Department:

The discussion of the results in the Communication department highlights a shift from traditional media to digital interaction, which has enhanced the company's "Communicational Efficiency."

Digital Internal Communication:

The department relies on internal digital networks and professional email systems to circulate administrative notes and internal news.

Impact on Efficiency: This has replaced the slow, paper-based distribution of information. The result is a faster flow of data between the central management and the various sites of GCB, ensuring that all employees receive instructions simultaneously, which minimizes coordination errors.

External Digital Presence (Social Media and Website):

The company maintains an active presence on social media platforms and its official website.

Impact on Efficiency: These tools have become an efficient way to provide real-time updates on projects and news without the need for high-cost traditional advertising. This digital presence has improved the transparency of the institution and made it easier for stakeholders and the public to access information instantly.

Conclusion for this Department:

Digital transformation in the Communication department has led to a more responsive and agile institution. By reducing the time needed for information to travel, the department has achieved higher administrative efficiency, making the overall coordination within GCB more effective.

4.1.3 Human Resources (HR) Department:

The discussion of digital transformation in the HR department at GCB reveals a "Transition Phase" or what the employees describe as a "Hybrid Environment." While the software is effective, several infrastructure and cultural challenges impact the overall efficiency.

Infrastructure vs. Software Efficiency:

A significant finding in this department is the gap between software quality and hardware reliability. While the HR software is user-friendly and effective, the hardware (PCs) is often outdated and slow. This creates a paradox where employees, in their pursuit of efficiency, sometimes rely on personal laptops to complete their professional tasks on time. This indicates that "Technical Readiness" is still a barrier to reaching the full potential of digital efficiency.

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The "Double Work" Challenge (Digital vs. Paper):

The results show that while digital data entry is faster, efficiency is hindered by the requirement for manual signatures and physical printing. This creates "double work," where a task is performed digitally and then repeated physically for official validation. This "paper-heavy" culture wastes a portion of the time saved by digital tools and keeps the administrative cycles from becoming fully smooth.

Cultural Resistance and the Generational Gap:

The discussion highlights a clear resistance to change, particularly among older staff. There is a psychological preference for paper, perceived as "safer and more reliable" than digital files. This lack of digital trust, combined with hardware frustrations, leads some employees to revert to traditional methods. This suggests that for GCB to achieve 100% digital efficiency, it must focus on "Digital Awareness" and intensive training to bridge this generational gap.

Performance Tracking and Innovation Space:

A critical gap identified in the interviews is the lack of specialized digital systems for measuring productivity (Metrics) or tracking employee performance automatically. Decisions regarding rewards or task distribution still rely heavily on personal observation and traditional reports. Furthermore, the current system is described as "rigid," providing limited space for employees to suggest digital innovations or engage in official "Self-Learning" platforms.

Conclusion for HR:

The HR department at GCB has successfully moved away from the "paper desert" of the past, but it has not yet reached a fully digital ecosystem. The current efficiency is "Improved but Fragmented." To move forward, the institution needs to upgrade its hardware infrastructure and transform its organizational culture to eliminate the reliance on physical paper and manual signatures.

4.1.4 Finance and Accounting Department:

The discussion of the results within the Finance and Treasury department reveals a profound shift toward high-level institutional efficiency. Based on the interviews conducted with department experts, the digital impact can be discussed through the following strategic dimensions:

Speed and Time Efficiency (Avoiding Financial Penalties):

The results confirm that digital transformation has significantly optimized the duration of daily operations. A critical finding is the role of digitalization in the treasury; the reduction in time between receiving and executing financial requests is not just a matter of speed, but a risk management strategy. By using digital systems, GCB ensures that files are processed within the required timeframes to avoid financial fines and penalties that could result from

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delays in bank or tax obligations. This "Preventive Efficiency" is vital for maintaining the company's financial health.

Effectiveness of Specialized Systems (JIBAYATIC, EDI, and BIG FINANCIER):

The discussion highlights the vital reliance on specialized banking and tax applications. Systems such as EDI (Electronic Data Interchange), JIBAYATIC (for tax services), and BIG FINANCIER have made financial operations instant. These tools have transformed the institution's information system by automating data monitoring. Instead of manual entry, these applications discover and correct errors automatically, which increases "Operational Effectiveness" and ensures the highest degree of accuracy in accounting records.

Productivity and Workload Management:

Interestingly, the results show that the true profitability of digital transformation at GCB is most visible during "Information Pressure" or heavy workloads. While the volume of work might not always increase, the capacity to handle complex tasks and manage a larger number of projects has improved. Digital tools have simplified the acquisition of new projects by making the associated administrative and financial tasks easier to execute, thereby increasing the company's "Task Capacity."

Resource Optimization and Decision-Making:

There is clear evidence of a reduction in the waste of resources (time, effort, and paper). Beyond cost-saving, digitalization has directly improved the "Decision-Making Efficiency." Management at GCB now relies entirely on accurate digital reports to make strategic decisions. The availability of real-time digital data ensures that financial decisions are the "most correct and accurate," reducing the margin of human error and improving the overall quality of the institution's final outputs.

Conclusion for Finance Department:

In conclusion, digital transformation in the Finance department has moved GCB from a traditional, reactive state to a proactive, precision-based model. By integrating specialized platforms, the department has achieved a dual goal: Economic Efficiency through cost and penalty reduction, and Strategic Efficiency through high-quality, data-driven decision-making.

4.2 Comparison of Results with Previous Studies:

After analyzing the field data at GCB, this section aims to compare our findings with the results of previous national and international studies to identify points of agreement and divergence.

4.2.1 Points of Agreement:

Our study at GCB strongly aligns with several previous research findings regarding the positive impact of digital transformation on efficiency:

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Operational and Financial Efficiency: Similar to the findings of Rezkallah (2025) at SATIM and Ibrahim (2025) at CEVITAL, our results confirm that digitalization acts as a primary lever for optimizing internal processes. The use of specialized systems at GCB (like JIBAYATIC and BIG FINANCIER) has led to faster procedures and a reduction in operational errors, which mirrors the conclusions of Benyahia & Guettafi (2025) regarding the improvement of administrative speed.

Time and Cost Reduction:

Our findings support the results of Benzaoui and Dahmani (2023), showing that digitalization significantly reduces the time spent on repetitive tasks. Furthermore, the ability to avoid financial penalties through faster processing in the treasury department at GCB is consistent with the cost-reduction objectives highlighted by Gueraziz (2024) and Tikialine (2025).

Decision-Making Quality: Like the study of Khentit (2024) at Brandt, our results show that the integration of digital tools enhances the quality of final outputs and provides a reliable database for strategic decisions.

4.2.2 Points of Divergence and Unique Findings:

While the theoretical impact is consistent, our field study at GCB revealed specific challenges that distinguish our results from some of the more "optimistic" previous studies:

The Infrastructure Gap: While many studies (e.g., Belhadi et al., 2024) emphasize the success of digital tools, our study highlights a critical "Hardware-Software Paradox." At GCB, the effectiveness of advanced software is hindered by outdated hardware (PCs) and weak internet speed in remote sites—a reality also touched upon by Ben Ahmed & Ben Ahmed (2025) regarding national technical challenges.

The "Hybrid Environment" and Cultural Resistance: Unlike some studies that focus purely on technical adoption, our research at GCB identified a strong "Cultural Resistance" among older employees. This confirms the warnings of Arribi & Boutarfa (2024) and Tikialine (2025) that a "Digital Culture" is just as important as the technology itself. The persistence of "Double Work" (digital entry followed by manual signing) at GCB is a unique observation that explains why the transition in some Algerian institutions remains incomplete.

4.2.3 Summary of Comparison:

In summary, the case study of GCB confirms the general academic consensus that digital transformation is a necessity for achieving efficiency. However, it adds a realistic dimension: digitalization is not a "magic solution" that works in isolation. Its success at GCB is conditioned by the quality of the physical infrastructure and the readiness of the human resource to abandon old paper-based habits.

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4.3 Synthesis of Results and Evaluation of Hypotheses:

After analyzing the qualitative data collected through interviews and direct observation at GCB, we can now synthesize the findings and evaluate the research hypotheses formulated at the beginning of this study.

4.3.1 Evaluation of the First Hypothesis:

Hypothesis: *"Digital transformation contributes positively to improving efficiency within GCB through the effective use of digital tools."*

Evaluation: Confirmed. The field study demonstrated that the adoption of digital systems (such as JIBAYATIC and specialized IT monitoring tools) has transformed traditional workflows. The employees' responses indicated that whenever digital tools are fully integrated, there is a noticeable improvement in overall institutional performance. However, this contribution is currently constrained by the "Hardware-Software Paradox" identified in the HR department.

4.3.2 Evaluation of the Second Hypothesis:

Hypothesis: *"Digital tools accelerate the speed and fluidity of internal communication between departments."*

Evaluation: Partially Confirmed. While digital platforms (professional email and internal networks) have significantly improved the flow of information between the headquarters in Boumerdes and other sites, the "fluidity" is still interrupted by traditional habits. The requirement for manual signatures on digital documents—what we described as the "Hybrid Environment"—prevents the communication from being 100% fluid.

4.3.3 Evaluation of the Third Hypothesis:

Hypothesis: *"Using digital systems in finance and administration leads to more correct results and saves time."*

Evaluation: Strongly Confirmed. This hypothesis showed the highest level of validation. The use of EDI, JIBAYATIC, and BIG FINANCIER in the Finance department has directly led to "Higher Correctness" and "Time Saving." More importantly, it has proven to be a strategic tool for avoiding financial penalties and tax errors, which perfectly aligns with the goal of increasing efficiency.

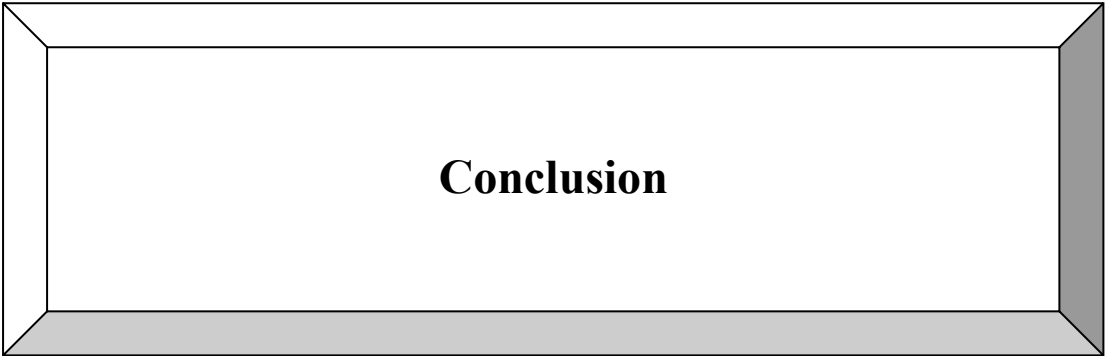
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Summary of the Chapter two:

The empirical study conducted within the National Company for Civil Engineering and Construction (GCB) has provided a practical dimension to our research on digital transformation and its impact on institutional efficiency. By moving from the theoretical concepts to field reality, we were able to observe the actual integration of digital tools and their direct influence on daily operations.

The findings of this chapter reveal that GCB has successfully crossed the initial threshold of digitalization. The reliance on specialized systems like JIBAYATIC, EDI, and BIG FINANCIER has proven that technology is an essential lever for ensuring financial accuracy and avoiding operational delays. However, the study also uncovered significant "bottlenecks," most notably the technical gap in hardware infrastructure and the cultural persistence of paper-based procedures.

In conclusion, while the first chapter established that digital transformation is a theoretical driver of efficiency, this second chapter confirms that its success in the Algerian economic context depends heavily on the harmony between modern software, robust hardware, and a supportive organizational culture. The "Hybrid Environment" currently observed at GCB represents a critical transition phase toward a fully digitalized future



Conclusion

In an era of rapid technological growth, digital transformation has emerged as a vital necessity for economic institutions to ensure their sustainability and competitiveness. This study addressed a central research problem: assessing the extent to which digital transformation contributes to improving efficiency within the National Company for Civil Engineering and Construction (GCB).

This objective was achieved by adopting the Descriptive Approach, relying on direct observation and semi-structured interviews across various departments, including Information Technology (IT), Finance, Human Resources (HR), and Communication. Based on the findings, we proceed to evaluate the research hypotheses:

The first hypothesis, which posited that digital transformation contributes positively to improving efficiency within GCB through the effective use of digital tools, was confirmed. The field study demonstrated that the integration of specialized systems (such as JIBAYATIC and IT monitoring tools) has fundamentally transformed traditional workflows, leading to enhanced overall institutional performance.

The second hypothesis stated that digital tools increase the pace and fluidity of internal communication between departments. This hypothesis was partially confirmed. While digital platforms, such as professional email and internal networks, have improved the flow of information, the persistence of manual signatures and paper-based requirements—a "Hybrid Environment"—continues to hinder the full fluidity of communication.

The third hypothesis, which asserted that using digital systems in finance and administration leads to more correct results and saves time, was strongly confirmed. The adoption of EDI, JIBAYATIC, and BIG FINANCIER in the Finance department has directly improved the quality of financial results, reduced human errors, and served as a strategic tool to avoid financial penalties and tax-related delays.

Following the evaluation of the hypotheses, the following key findings were obtained:

- Digital transformation at GCB has led to significant "Time Efficiency" and tangible accuracy, particularly in departments handling complex regulatory and banking tasks.
- The true value of digitalization at GCB is most evident during periods of "Workload Pressure," where digital systems provide the necessary agility to manage multiple projects simultaneously.
- A "Gap between Hardware and Software" exists within the institution, where the effectiveness of advanced software is limited by outdated equipment and infrastructure challenges.
- Resistance to change among some staff members remains a significant organizational barrier, preventing the full transition toward a completely digital environment.

Based on these findings, the following recommendations are proposed:

Infrastructure Modernization: Prioritizing the upgrade of hardware (PCs and servers) to ensure full compatibility with the modern software currently in use.

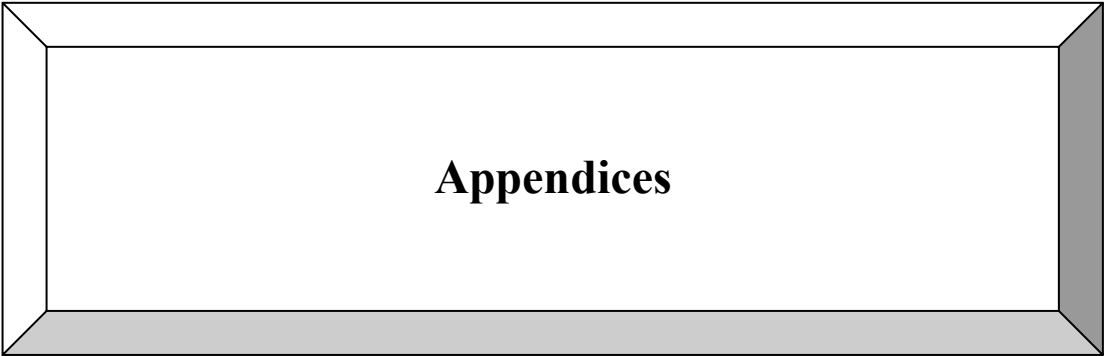
Activating E-Signatures: Transitioning toward digital authentication systems is essential to eliminate "double work" and ensure fully digitalized administrative cycles.

Continuous Digital Training: Organizing specialized training sessions to raise digital awareness among employees and reduce resistance to new technologies.

Developing Digital Performance Metrics: Integrating digital systems to track worker productivity and project progress in real-time for more objective decision-making.

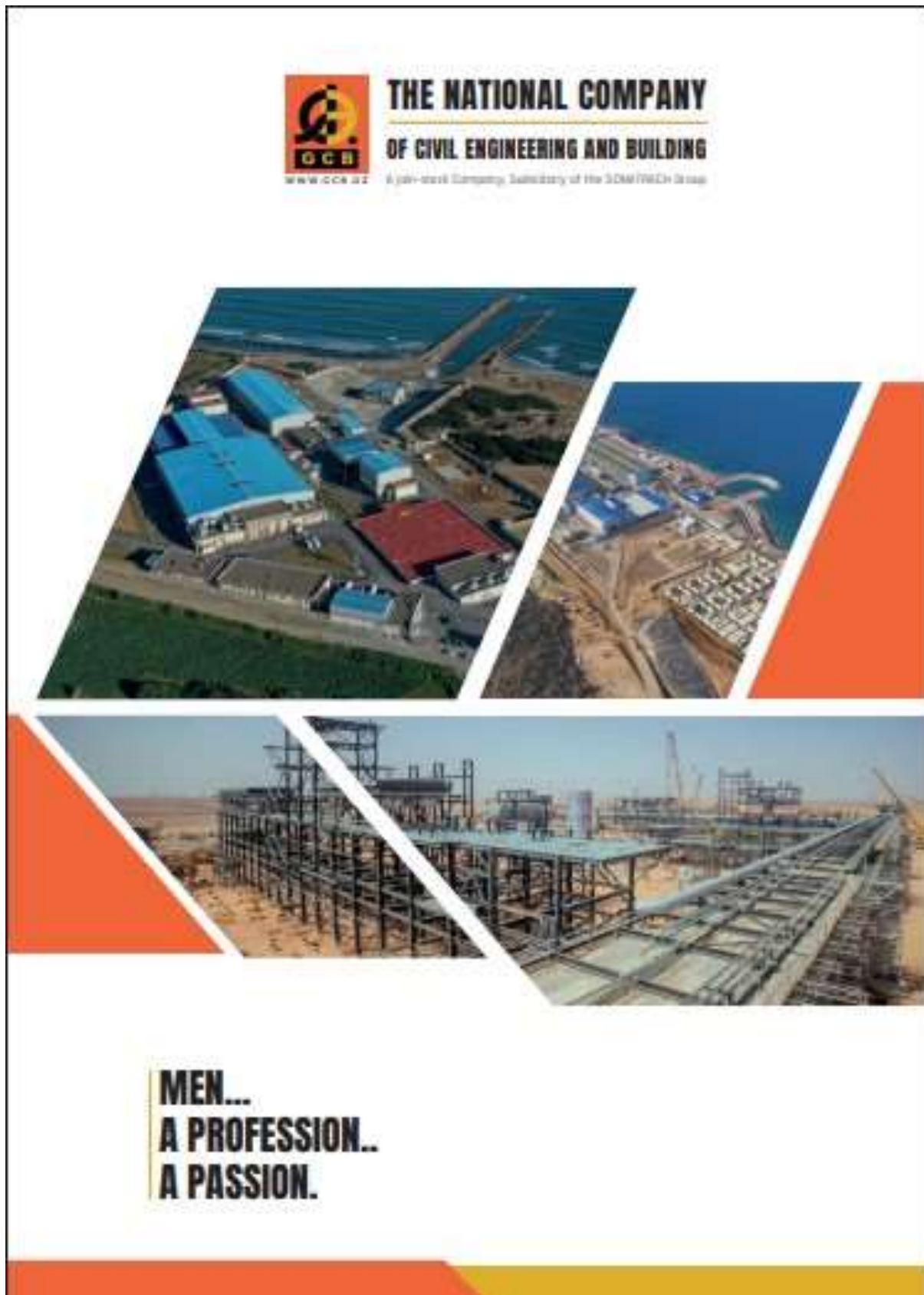
Based on the above recommendations, several research prospects emerge as scientific extensions of this work:

- Studying the role of Artificial Intelligence (AI) in optimizing supply chain management within the Algerian construction sector.
- Investigating Cybersecurity strategies for protecting institutional data in fully digital environments.
- Conducting a comparative study of digital maturity between public and private construction firms in Algeria.



Appendices





Société Nationale de Génie Civil et Bâtiment

GCB / Spa - Filiale Sonatrach

BACHA Nassima épouse TAZEROUTI

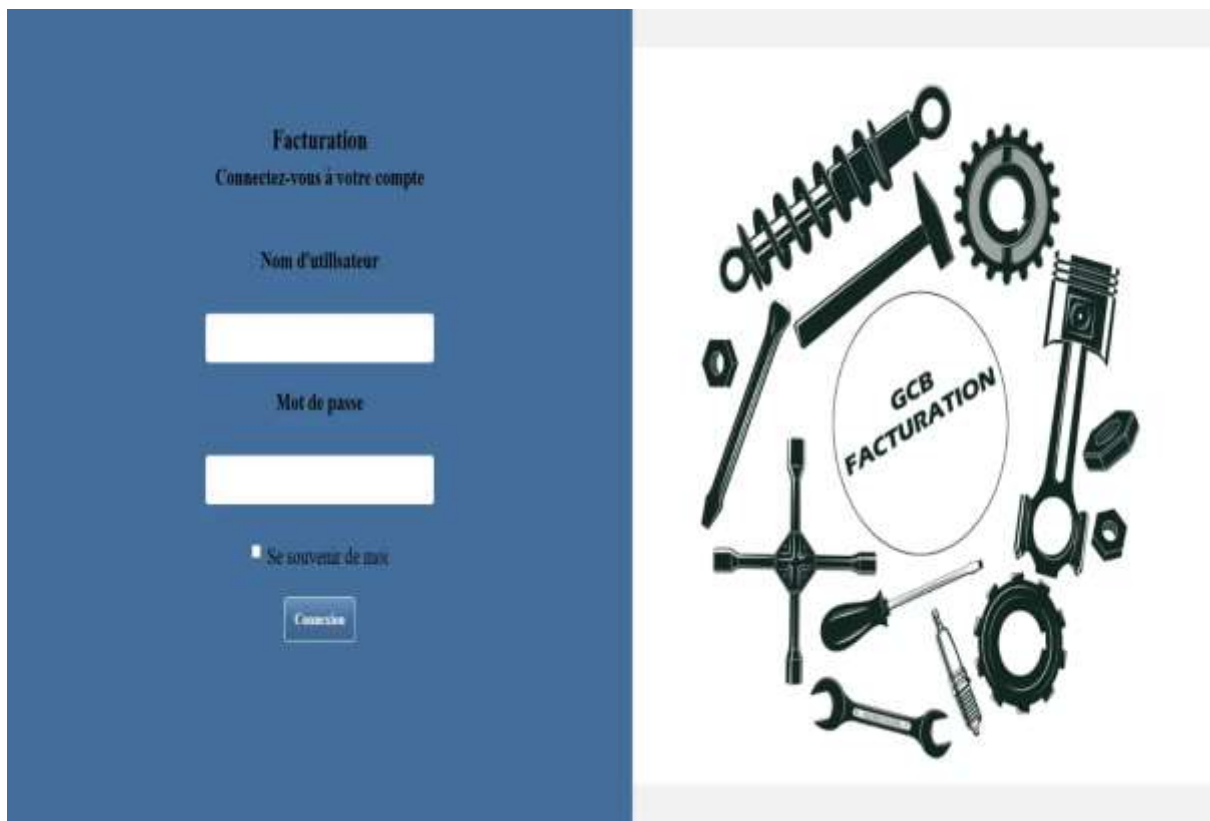
Chef de Service Trésorerie



S.S: Prolongement Boulevard de l'ALN, BP 110, Boumerdès

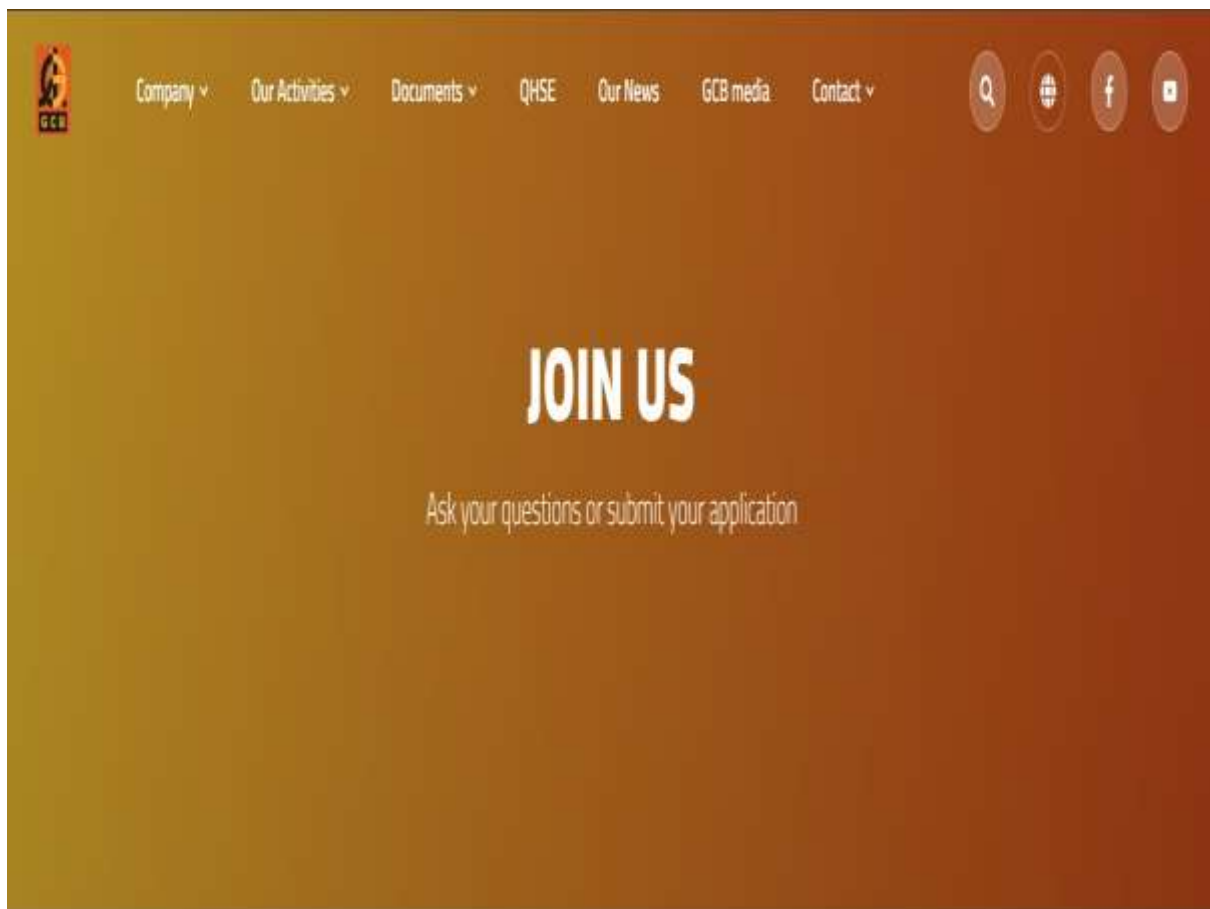
Mob: 0549 43 80 27 - Fax: (+213) 24 79 76 91

E-mail: tresorerie.fn@gcb.dz





Appendix6 :Join Us" Web Interface for Career Opportunities at GCB



Appendix 7 :Digital Interface for CV Submission and Candidate Registration

The screenshot displays a web application interface for CV submission and candidate registration. At the top, a dark navigation bar contains the GCB logo, a menu with links to 'Company', 'Our Activities', 'Documents', 'QHSE', 'Our News', 'GCB media', and 'Contact', and social media icons for search, a grid, Facebook, and YouTube. The main content area is titled 'Request Type' and features a form with three sections: 1. 'Submit my CV (Job Application)' with a dropdown arrow. 2. 'Specialty' with a dropdown menu showing '-- Select your specialty --'. 3. 'Your CV (Attachment)' with a file selection button that says 'Click to select your CV' and a note 'Accepted formats: PDF, DOC, DOCX (Max 5 MB)'. A large orange 'Send Message' button is at the bottom center, and a small icon with an upward arrow is in the bottom right corner.

Request Type *

Submit my CV (Job Application) ▼

Specialty *

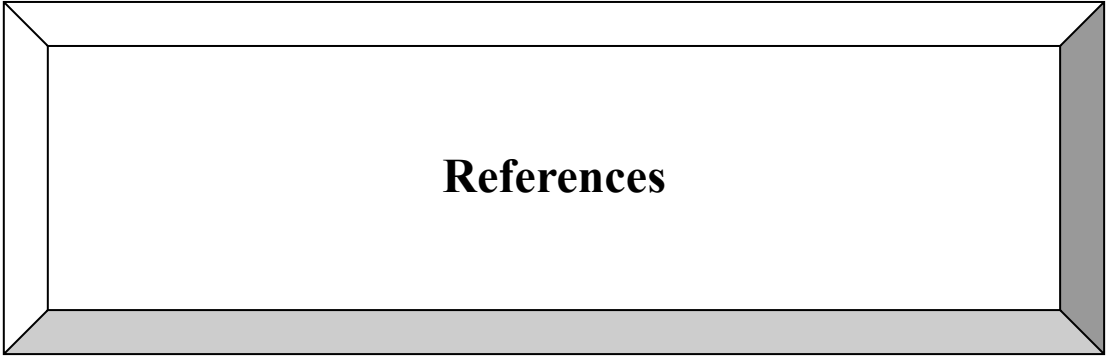
-- Select your specialty -- ▼

Your CV (Attachment) *

Click to select your CV

Accepted formats: PDF, DOC, DOCX (Max 5 MB)

Send Message



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