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«ENTREPRENEURSHIP AND PROJECT MANAGEMENT»

**Contributing to the Improvement of Maintenance  
Function Performance in Energy Companies through  
Project Management Digital Tools: A Case Study of  
Schneider Electric Algeria**

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## ABSTRACT

One of the key determinants in project completion, continuity, and overcoming operational challenges in the energy sector is the maintenance function. This study examines the role of maintenance performance in strategic planning and its impact on overall project performance, as deficiencies in any aspect of maintenance can lead to economic repercussions and safety risks.

This study employed an analytical methodology to evaluate the performance of maintenance teams using MS Project software as a scheduling and task management tool. The findings indicate that the optimal use of digital planning tools effectively contributes to prioritizing tasks, improving the allocation of human resources (maintenance technicians), and developing work procedures, thereby reducing unplanned downtime and enhancing project efficiency.

**Key Words: Project Management, Project, Planning, Maintenance Function, Project Management Digital Tools.**

## RÉSUMÉ

La maintenance est un facteur déterminant pour la réussite et la continuité des projets, ainsi que pour la résolution des difficultés opérationnelles dans le secteur de l'énergie. Cette étude vise à analyser le rôle de la performance de la maintenance dans la planification stratégique et son impact sur la performance globale des projets. En effet, toute défaillance en matière de maintenance peut engendrer des répercussions économiques et des risques pour la sécurité.

Cette étude adopte une approche analytique pour évaluer la performance des équipes de maintenance grâce au logiciel MS Project, employé comme outil de planification et de gestion des tâches. Les résultats montrent qu'une utilisation optimale des outils numériques de planification contribue à la priorisation des tâches, à l'amélioration de l'affectation des ressources humaines (techniciens de maintenance) et au développement des procédures de travail, ayant pour effet de réduire les temps d'arrêt non planifiés et d'optimiser l'efficacité des projets.

**Mots clés : Management De Projet, Projet, Planification, Fonction De Maintenance, Outils Numériques De Management De Projet.**

### **ملخص**

أحد المحددات الرئيسية في انجاز المشاريع، استمراريته وتجاوز التحديات التشغيلية في مجال الطاقة هي وظيفة الصيانة، تهدف هذه الدراسة على التركيز على دور أداء وظيفة الصيانة في التخطيط الاستراتيجي تأثيرها على الأداء العام للمشاريع حيث القصور في تأدية أي جانب من جوانبها يؤدي الى تداعيات اقتصادية ومخاطر متعلقة بالأمن والسلامة.

اعتمدت هذه الدراسة على منهجية تحليلية لتقييم أداء فرق الصيانة باستخدام برمجية MS Project كأداة لإدارة الجدولة والمهام. ولخصت النتائج إلى أن التوظيف الأمثل للأدوات الرقمية للتخطيط يساهم بشكل فعال في تحديد الأولويات، تحسين توزيع الموارد البشرية (فنيي الصيانة)، وتطوير إجراءات العمل، مما يقلل من فترات التوقف غير المخطط لها ويعزز كفاءة المشروع.

**الكلمات المفتاحية:** إدارة المشاريع، المشروع، التخطيط، وظيفة الصيانة، برمجيات إدارة المشاريع.

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With immense gratitude, I dedicate this work to those who have been my greatest supporters throughout my life:

I dedicate this work to myself, for my perseverance in the face of adversity and my ability to rise again after every fall. This is not merely an academic achievement, but the fruit of a journey undertaken, of sacrifices and efforts. I have been able to transform my dreams into reality, despite the obstacles. Today, I am proud of the path I have completed with courage and determination.

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## LISTE OF ABRIVIATIONS

**CMMS:** Centralized maintenance management system.

**CPI:** Cost Performance Index.

**EAC :** Estimate at Completion.

**ENSM :** École Nationale Supérieure De Management.

**ERP:** Enterprise resource planning.

**ETC:** estimate to complete.

**FAT:** Factory acceptance test.

**GCT:** Generalized Cost of Transport.

**ITS:** Intelligent transport systems.

**KPIs:** Key performance indicators.

**LOS:** Level of service.

**LV:** Low-voltage.

**MADU:** Material Available for Dispatch.

**MS Project:** Microsoft Project.

**MTBF:** Mean Time Between Failures.

**MTTR:** Mean Time To Repair.

**MV:** Medium Voltage.

**PdM:** Predictive maintenance.

**PM:** Project management.

**RACI:** Responsibility assignment matrix.

**SCADA:** Supervisory Control and Data Acquisition.

**SEA:** Schneider Electric Algeria.

**SOG:** slab on grade.

**SPI:** Schedule Performance Index.

**VDC:** Volt direct current.

**WBS:** Work Breakdown Structure.

## **INTRODUCTION:**

Energy infrastructure represents a critical sector where operational disruptions can lead to significant service interruptions, financial implications, and safety challenges. Within this demanding environment, the maintenance function serves as a primary pillar responsible for ensuring system reliability and asset integrity. However, modern maintenance management requires navigating complex challenges in scheduling precision, resource optimization, and the mitigation of unforeseen operational delays. While foundational literature has long recognized maintenance as a holistic, integrated organizational system (Duffuaa & Raouf, 2015) and established it as a strategic cornerstone for structural success (Gits, 1984), there is a distinct need to expand these frameworks to incorporate the ongoing paradigms of digital transformation.

In the contemporary industrial landscape, the digitalization of maintenance has become increasingly important for performance optimization. Digital project management tools provide a critical structural link between high-level maintenance strategies and real-world field execution, particularly during unexpected technical failures. In these complex operational situations, traditional manual scheduling methods can face limitations, as they may lack the capacity to process high volumes of real-time data rapidly enough to address urgent infrastructure needs. Conversely, digital solutions offer enhanced real-time visibility, enabling planning managers to perform dynamic rescheduling. This digitized agility allows organizations to immediately evaluate how a specific breakdown affects the critical path, thereby facilitating the precise reassignment of technical personnel and spare parts. Consequently, this digital flexibility serves as an important factor in minimizing the Mean Time to Repair (MTTR) and safeguarding a continuous energy supply. Despite the global trajectory toward industrial digitalization, empirical research regarding emerging markets—particularly within the Algerian context—remains relatively limited. Specifically, there is a lack of documentation on the technical operationalization, meaning the practical application and comprehensive utilization, of integrated digital project management tools within the Algerian energy sector. Furthermore, the inherently unpredictable nature of maintenance, characterized by volatile failure patterns, frequently highlights the constraints of the traditional Critical Path Method (CPM), which can prove too rigid when applied to high-uncertainty environments. As a prominent technology provider in the Algerian market, Schneider Electric Algeria—the local subsidiary of the global leader in energy management and industrial automation—serves as the empirical foundation for this study. The organization delivers specialized hardware, software, and

digital solutions tailored to the energy, infrastructure, and industrial sectors through its core operations in energy management, industrial automation, and comprehensive technical support. Within this organizational structure, the maintenance and project departments function in a highly integrated environment. Utilizing Schneider Electric Algeria as a case study, this research aims to address the existing literature gap by investigating how the strategic integration of project management digital tools can transition beyond basic data logging to serve as a primary driver of operational performance improvement. Ultimately, this study seeks to demonstrate how these digital tools can ensure that field operations and scheduling interventions remain resilient, thereby synchronizing maintenance activities to maintain high performance standards even during demanding operational crises within a regulated sector.

### **1.1 Problem Statement**

To optimize operational workflows and address maintenance challenges within the energy sector, the integration of digital solutions is examined. The primary research problem is subsequently introduced, focusing on the relationship between these technological systems and operational efficiency.

- main problem statement: How do Project management digital tools improve the scheduling efficiency and general performance of maintenance projects in energy utilities?

### **1.2 Research Questions**

- **Secondary question 1:** How well do project management digital tools help to organize task tracking and resource allocation in maintenance projects inside of energy utilities?
- **Secondary question 2:** what are the primary performance indicators used to assess maintenance project success?

### **1.3 Research objectives**

To address the core questions of this study, the following research objectives are defined:

- To examine the link between better maintenance project schedule adherence and effective utilization of project management digital tools, specifically regarding critical path method and baseline tracking.
- To assess how integrated digital scheduling tools facilitate optimized resources (personnel, equipment) and tracking in maintenance projects to avoid bottlenecks.

- To define a framework of maintenance Key Performance Metrics (KPIs) used by Schneider Electric Algeria that can be effectively monitored through integrated project management digital tools.
- To provide Schneider Electric and its utility customers with strategic recommendations for maximizing service reliability and reducing Mean Time to Repair (MTTR) through advanced project management software solutions.

#### **1.4 Significance of the Study**

To highlight the practical and theoretical value of this research, the significance of the study is outlined below:

- **For Schneider Electric:** Offers best practice guidelines and empirical data to improve service offerings associated with software implementation and maintenance project management.
- Provides clear ideas on how to maximize project scheduling to minimize expensive downtime and so enhance regulatory compliance and consumer satisfaction (service dependability).
- Contributes to the body of knowledge on the use of general-purpose PM digital software (MS Project) in specialized, critical-path environments for Project Management.

# **CHAPTER I: CONCEPTUAL AND METHODOLOGICAL FRAMEWORK**

## **1 Maintenance :**

This section establishes the foundational concepts and technical definitions of the maintenance function before evaluating the distinct asset management strategies utilized in industrial operations. By systematically assessing both reactive and proactive approaches, the analysis examines the organizational frameworks and economic implications that link equipment reliability directly to corporate performance, cost optimization, and overall operational profitability.

### **1.1 Overview of maintenance:**

Duffua and Raouf argued that maintenance is « the combination of activities by which equipment or a system is kept or restored to a state in which it can perform its designated function. It is an important factor in product and service quality and can be used as a strategy for successful competition. » (Duffuaa & Raouf, 2015)

The maintenance is a process of which preserve or maintain the object to its functional or original state.

According to Gits (1989): «Geraerds (1972) introduces the maintenance conception as the total of determined directives dealing with the way an object is expected to be maintained in the using organization. » (Gits, 1984)

### **1.2 Maintenance strategies :**

The maintenance methodology serves as a critical, structural bridge between overarching corporate objectives and tactical asset management. By anchoring maintenance goals to the organization's broader mission, decision-makers ensure that asset reliability directly supports competitive advantage and operational continuity. However, translating this strategic alignment into practical execution demands a tailored operational framework. The efficacy of the methodology hinges on selecting, balancing, and applying specific maintenance strategies in a cohesive mix suited to the organization's unique operational context. Based on the framework established by (Duffuaa & Raouf, 2015, pp. 5-7) , these strategies provide a systematic approach to optimizing resource utilization and minimizing downtime. To operationalize this methodology, the strategies are outlined as follows:

- Breakdown/corrective maintenance
- Preventive maintenance:
  - Time- or use-based preventive maintenance
  - Condition-based preventive maintenance
- Opportunity maintenance
- Fault finding
- Design modification
- Overhaul
- Replacement
- Reliability-centered maintenance
- Total productive maintenance

#### **1.2.1 Breakdown/Corrective Maintenance :**

This type of maintenance is only performed when the equipment is incapable of further operation. There is no element of planning for this type of maintenance. This is the case when the extra cost of other types of maintenance cannot be justified. This type of strategy is sometimes referred to as run to failure strategy. It is applicable mostly to electronic components

#### **1.2.2 Time- or Use-Based Preventive Maintenance:**

Preventive maintenance (PM) is any planned maintenance performed to counteract potential failures. It could be implemented based on the use or equipment condition. The time- or use-based PM is performed on hours run or calendar basis. It needs a high level of planning. The specific routines to be carried out are known as well as their frequencies. In determining the frequency, usually knowledge about failure distribution or equipment reliability is needed

#### **1.2.3 Condition-Based Preventive Maintenance:**

Condition-based maintenance is carried out on the basis of the known condition of the equipment. The condition of the equipment is determined by monitoring key equipment parameters whose values are affected by the condition of the equipment. This strategy is also known as predictive maintenance.

#### **1.2.4 Opportunity Maintenance:**

This type of maintenance, as the name implies, is carried out when the opportunity arises. Such opportunities may arise during shutdown periods of a particular system and can be utilized for carrying out known maintenance tasks.

#### **1.2.5 Fault Finding:**

Fault finding is an act or inspection performed to assess the level of failure set on. An example of fault finding is checking the spare tire of a car prior to taking a long trip.

#### **1.2.6 Design Modification:**

Design modification is carried out to bring equipment to a current acceptable condition. It involves improvement and sometimes manufacturing and capacity expansion. It usually requires coordination with engineering and other departments in the organization to do this type of work.

#### **1.2.7 Overhaul:**

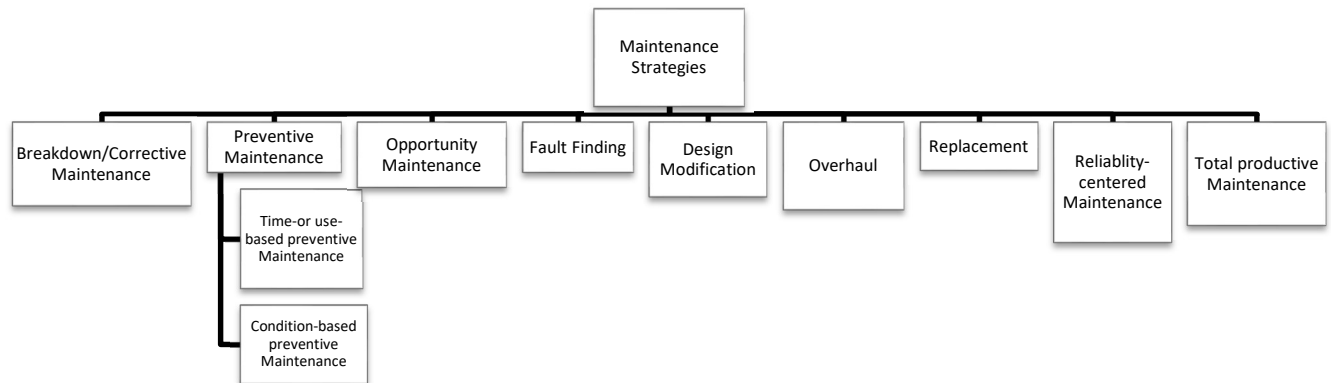
Overhaul is a comprehensive examination and restoration of equipment or a major of equipment to an acceptable condition. This is usually a major task.

#### **1.2.8 Replacement:**

This strategy is to replace the equipment instead of performing maintenance. It could be a planned replacement or replacement upon failure.

Each of the maintenance strategies described above has a role to play in the plant operation. It is the optimal mix of these maintenance strategies that results in the most effective maintenance philosophy. The size of the plant and its planned level of operation coupled with the applicable maintenance strategy can assist in estimating the maintenance load or the desired output of the maintenance system. Figure 1 summarizes the maintenance strategies.

**Figure 1: Maintenance strategies**



**Source :** (Duffuaa & Raouf, 2015).

### 1.3 The maintenance function within the company:

The evolution of the maintenance function represents a significant paradigm shift from a purely reactive, corrective model to a proactive, integrated component of modern organizational operations. Historically viewed as an ancillary cost center responsible only for restoring failed equipment to operational status, contemporary maintenance management is recognized as a strategic lever that directly shapes the production system's overall efficiency and economic viability. By governing key operational variables—such as equipment availability, production volume, process quality, and operational reliability—the maintenance function directly influences the organization's bottom line and competitive positioning in the marketplace.

Consequently, the mandate of the maintenance department extends far beyond basic mechanical intervention. Under the strategic direction of maintenance management, the department is tasked with optimizing the performance of the entire production process. This involves minimizing unplanned downtime, reducing the total cost of maintenance, and ensuring a continuous, reliable flow of production. Furthermore, modern asset management encompasses the critical responsibility of safeguarding human capital and physical assets, ensuring the long-term structural and functional integrity of the production

systems, and maintaining an operational environment that meets industrial safety and environmental standards. Through this holistic approach, the maintenance function transforms from a simple repair unit into a cornerstone of operational excellence and corporate profitability. (SAADOUNE, 2017, p. 19)

#### **1.4 The core missions & objectives of the maintenance department:**

Maintenance strategic planning is a long-range planning and is concerned with the determination of maintenance mission, strategic goals, and objectives. The mission and the strategic goals are derived and aligned with organization's mission and goals. Then, maintenance strategies and programs are developed to achieve a set mission and goals. Maintenance capacity planning is medium- to long-range planning for maintenance involves the determination of the maintenance resources that are needed to perform the maintenance load in order to achieve organizational objectives such as availability, reliability, quality rates and delivery dates. Maintenance forecasting is an essential activity for planning. Maintenance forecasting comprises the estimation and prediction of the maintenance load. The maintenance load drives the whole maintenance system, and it consists of two major categories. The first category is the scheduled and planned maintenance which is formed of (1) routine and preventive maintenance, (2) scheduled overhauls which involve closure or plant shutdown, (3) corrective maintenance that involves determining the causes of repeated breakdown and substandard performance as a result of design malfunction, and (4) scheduled overhaul, repair, or building of equipment which is not covered under item 2. The second category is emergency or breakdown maintenance load. This category depends primarily on the failure pattern, and it is a major source of uncertainty in the planning process. The sum of the maintenance load for the two categories is a random variable, and it is the major factor in determining maintenance capacity. (Duffuaa & Raouf, 2015, p. 19)

#### **1.5 Economic impact of maintenance:**

The strategic role of the maintenance and asset management function extends far beyond mere upkeep, serving as a fundamental driver of a company's competitive advantage through its influence on core product and service attributes. While maintenance does not directly dictate the inherent functionality of a product, its execution has a profound impact on both the pricing model and the quality of the output. From a cost perspective, an

optimized maintenance strategy mitigates unplanned downtime and extends asset lifecycles, enabling a firm to maximize production capacity while reducing overall operational expenses. This reduction in the cost of failure and maintenance overhead directly influences the pricing strategy, allowing the enterprise to offer more competitive rates without sacrificing profit margins.

Regarding quality, the notion that one can consistently produce high-quality products using poorly maintained equipment is a misconception that fails under rigorous operational scrutiny. In modern quality management systems, such as those governed by ISO 9000 or QS 9000 standards, the condition and capability of equipment are subject to strict evaluation. Asset reliability is directly correlated with process stability; degraded machinery introduces variability in manufacturing tolerances, thereby increasing defect rates. Consequently, consistent product quality requires a proactive and predictable asset management regime that prevents mechanical drift and ensures process accuracy.

Furthermore, the customer relationship attribute relies heavily on the organization's ability to meet delivery and response-time expectations. Equipment reliability forms the bedrock of an effective Just-in-Time (JIT) production strategy, which depends on synchronized material flow and zero-defect processes. When equipment is properly maintained, it yields higher availability and operational efficiency. This high degree of asset utilization ensures strict adherence to production and service schedules, resulting in precise delivery timing and predictable pricing. Ultimately, the stability provided by robust maintenance practices minimizes supply chain disruptions, reduces lead times, and enhances overall customer satisfaction. (Wireman, 2005, p. 230)

## **2 Maintenance scheduling and project management via MS project:**

According to Richard Palmer's principles of maintenance planning, the integration of planning and scheduling is essential for operational efficiency. The fundamental rationale is that direct labor productivity often referred to as "wrench time" cannot be effectively improved unless maintenance crews are consistently provided with a well-organized and continuous pipeline of work.

## 2.1 Project Scheduling and Management in Maintenance:

Effective scheduling is inherent in effective planning. Together, these principles create a framework for successful scheduling of planned maintenance work. Each principle sets guidelines on how maintenance should handle a different portion of the scheduling process. (Palmer, 2006, p. 73)

Just as for planning, six principles greatly contribute to the overall success of scheduling. First, planners plan jobs for the lowest required skill levels. Second, the entire plant must respect the importance of schedules and job priorities. Third, crew supervisors forecast available work hours one week ahead by the highest skills available. Fourth, the schedule assigns planned work for every forecasted work hour available. And sixth, schedule compliance joins wrench time to provide the measure of scheduling effectiveness. and the six maintenance scheduling principles are: (Palmer, 2006, pp. 73-74)

- Job plans providing number of persons required, lowest required craft skill level, craft work hours per skill level, and job duration information are necessary for advance scheduling.
- Weekly and daily schedules must be adhered to as closely as possible. Proper priorities must be placed on new work orders to prevent undue interruption of these schedules.
- A scheduler develops a one-week schedule for each crew based on a craft hours available forecast that shows highest skill levels available, job priorities, and information from job plans. Consideration is also given to multiple jobs on the same equipment or system and of proactive versus reactive work available.
- The one-week schedule assigns work for every available work hour. The schedule allows for emergencies and high priority, reactive jobs by scheduling a sufficient amount of work hours on easily interrupted tasks. Preference is given to completing higher priority work by under-utilizing available skill levels over completing lower priority work.
- The crew supervisor develops a daily schedule one day in advance using current job progress, the one-week schedule and new high priority, reactive jobs as a guide. The crew supervisor matches personnel skills and tasks. The crew supervisor handles the current day's work and problems even to rescheduling the entire crew for emergencies.
- Wrench time is the primary measure of workforce efficiency and of planning and scheduling effectiveness. Work that is planned before assignment reduces unnecessary

delays during jobs and work that is scheduled reduces delays between jobs. Schedule compliance is the measure of adherence to the one-week schedule and its effectiveness.

## **2.2 Technical operationalization of scheduling elements:**

The need and interest in project management methods are increasing in order to ensure calendar success and maintain permanence in the sector. Various methods are used in project planning, which is an important step in project management.

According to (Sökmen, 2022) critical path method CPM is a technique for scheduling a set of activities that are interdependent in terms of start and end times and eventually converge. In this technique, the aim is to determine the critical path to be considered in order to reach the endpoint in the stipulated time and to examine the alternatives that will occur in case the activity durations change. In order to understand CPM, some basic concepts should be known first. Project network is the visual that shows the activities and priority relationships in the project. Activity, any work that contributes to the completion of the project. A predecessor is an activity that must be completed before an activity can begin. ES is the earliest time an activity can start provided that all previous activities have been completed. Earliest Finish (EF) is the time found by adding the activity duration to the ES time of an activity. Latest Start (LS) is determined by subtracting the completion time of an activity from the LF. LF is the time found by adding the activity time to the LS time. Slack (S) is the time difference between the ES and LS or LF and EF times for an activity. The critical path is the path of critical activities that do not have slack time. Any delay in critical activities delays the overall project completion time and the project should be managed in a way that avoids delays in any of these activities. (Sökmen, 2022, p. 372)

the preparation of a CPM schedule includes the following steps:

### **2.2.1 Tasks management:**

Determine the work activities: Any project, no matter how large or small, must be divided into smaller entities, called activities, or tasks. An activity is a unique, definable element of work. In this step, there is no absolutely correct or incorrect breakdown. You may give the same project to 10 schedulers, and they may devise 10 different breakdowns, with some breakdowns being significantly different. In this regard, there are two schools of thought: (Mubarak, 2010, pp. 45-47)

- **Restrict the number of activities for the simplicity of the project schedule:** In this case, activities become “major” components. However, there is a practical—and sometimes contractual—limit on how large an activity may be. For instance, it is impractical to have Concrete Operations as one activity with 300 days’ duration. In addition, in many contracts, a maximum limit is set on the duration of any activity, usually about 14 to 30 days.
- **Break the project down into small activities:** This approach will result in a large number of activities. The main advantage of this approach is better control of the schedule during execution. You can easily tell the status (percent complete) of a small activity, such as Place Concrete for Spread Footings No. 23, better and more objectively than you can do so for a large activity, such as Building Foundation. The main disadvantage of having many activities is the additional work and hassle. However, this disadvantage may not be as important with the use of computers. Furthermore, you can roll up a group of activities into a major activity.

Factors considered in breaking down the project into individual activities for better control:

- **Nature of the work/Homogeneity:** It is impractical to put apples and oranges in the same basket. If the work involves two different materials and/or measured by different units, it must be divided into two different activities. For example, wall construction involves framing, drywall, and painting as basic different activities.
- **Location/floor:** Activities falling in different locations must be separated.
- **Size/duration:** For large activities or those with large quantity, it is better to divide the activities into small portions. For example, large excavation activities can be divided into smaller activities by grid or depth. For linear excavation, this can be divided by stations or 100-foot segments. This helps in measurement of work progress while execution. As mentioned earlier, this can be a contractual requirement.
- **Timing/chronology:** Sometimes a portion of the work maybe delayed purposely by the contractor. For example, a portion of the slab on grade (SOG) for a building maybe delayed till the end of the project because the area is being used as storage. Such portion must be considered as an activity by itself.
- **Responsibility:** Schedulers must break down pieces of work that are done by different parties (subcontractors). In case of schedule variance, it is important to indicate who is responsible for the variance.

- **Phase:** This can be a division made by the designer based on certain criteria such as timing, location, or other aspects.

**Determine activities' durations:** Techniques for estimating activity duration vary from one situation to another, depending on the type of work, the estimator, and other factors. Most activity durations can be estimated as follows:

Duration  $\frac{1}{4}$  Total quantity = Crew productivity. (Mubarak, 2010, pp. 45-47)

### 2.2.2 Operational Sequencing:

Determine logical relationships, this step is a technical matter. The scheduler should obtain this information from project managers and technical team leaders. Logical relationships should not be confused with constraints: (Mubarak, 2010, p. 49).

- A logical relationship exists between two activities when the start of one activity (or finish, as is explained in chapter 5) depends physically on the finish (or start) of another activity. For example, you cannot place the concrete until the formwork and reinforcement are erected. You cannot hang the dry wall until framing is done.
- A resource constraint (or restriction) is when you can theoretically do two tasks at the same time, but you schedule one as a predecessor of the other because of resource (labor, equipment) limitation. Some practitioners refer to the preceding two types of relationships as hard logic and soft logic, respectively. This terminology is scientifically suitable because hard logic cannot be relaxed under any circumstances, while soft logic can be relaxed if more resources are acquired.
- Another constraint is when an activity is subject to a (mostly subjective) constraint such as approval of an owner or a government agency, funding availability, or even workspace availability. Be careful not to confuse this type of constraint with a logical relationship. Typically, a good project schedule should only have a few constraints at most. (Mubarak, 2010, p. 49).
- Draw the logic network, and perform the CPM calculations. If you are using a computer program, it will perform these functions for you, provided that you have input the correct data. In this step, you will obtain the calculated finish date of the project, the critical path, and the available float for all noncritical activities. (Mubarak, 2010, p. 49)

### 2.2.3 Resources Optimization:

Resources in this context include labor, equipment, and materials. Cost loading is assigning the appropriate cost (or budget) to each activity. When the cost of all activities is

added up, it should equal to the project's budget. Resource allocation simply means assigning the right amount of resources to each activity at the right time. The objective of this step is to load each activity with the amount of resources it requires and, hence, calculate its budget. This can help link scheduling with estimating and accounting. At any point in the project, you should be able to tell the original (baseline) budget, actual cost, estimate to complete (ETC), estimate at completion (EAC), and other financial data for each activity and for the entire project. You may also link to cost accounting for procurement, invoicing, and other functions.

Resource loading along with the “Resource Dictionary”<sup>4</sup> will result in cost loading to each activity but in a smarter way than just assigning cost figures.

Resource leveling is simply trying to maintain uniform daily use of a resource (or resources) for the entire life cycle of the project or for the longest continuous segment of it. The objective of this step is to improve the efficiency of resource utilization (particularly labor and equipment) during the life cycle of the project. (Mubarak, 2010, pp. 49-50).

## **2.3 Performance tracking and KPIs :**

In order to define, capture and measure different aspects of value, we employ the concept of Key Performance Indicator (KPI).

### **2.3.1 Key Performance Indicator (KPI):**

represent a set of measures focusing on these aspects by linking broader objectives with project activities and outcomes. They provide us with an insight of the current state and at the same time a reference of where our performance should ideally reside, or simply how close or far we stand from an ultimate target. (Harmantzis , 2018, p. 8)

### **2.3.2 Categorization and Specification:**

In order to effectively present our KPI set, we group them according to basic objectives that constitute project (and business) success. Initially, we define our KPIs by mapping them into four key dimensions: Financial Results, Process Efficiency, Execution Performance, and Customer Satisfaction & Stakeholder Management. (Harmantzis , 2018, p. 8)

### **2.3.2.1 Financial Results:**

This area examines whether project outcomes meet business expectations in monetary terms. In this dimension, a project is primarily an investment that should bring back adequate profits to satisfy stakeholders. Financial KPIs are usually considered the most important, therefore they attract the most interest and concern from shareholders. (Harmantzis , 2018, p. 14)

Financial Results KPIs include: (Harmantzis , 2018, p. 14)

- Gross Profit Margin
- Return On Investment
- Project Outsourcing Index (% of scope)
- Project Outsourcing Index (% of budget)
- Cost of Project Management
- (Organization) Resources planned on project
- Procurement Operating Cost and Managed Spend.

### **2.3.2.2 Execution Performance:**

In this dimension, KPIs refer mainly in how consistently a project evolves against constraints of scope, time, cost, quality, resources, and risk as approved. It is a means of reassuring stakeholders that the project remains on budget, on schedule and within agreed specifications.

Execution Performance KPIs include: (Harmantzis , 2018, p. 15)

- Schedule Performance Index
- Cost Performance Index
- To Complete Performance Index
- Tasks Completed
- Delayed Tasks
- Missed Deadlines
- Missed Milestones
- Critical tasks in schedule

### **2.3.2.3 Process Efficiency:**

In this dimension, we concentrate on internal processes within an organization's boundaries and whether teams are efficient in meeting performance expectations. Project

management specific processes are also subject of examination. So, here we measure up to which extend processes are improved or hindered by project execution.

Process Efficiency KPIs include: (Harmantzis , 2018, p. 15)

- HR Utilization in Project
- Resource Availability Index
- Change Requests (number, frequency)
- Actual Work Hours vs Planed
- Purchasing Efficiency
- Upsell
- Suppliers' Fault/Inconsistency Index
- Supplier Dispersion Index
- Failures over Activity Category Index

### **2.3.3 Customer Satisfaction & Stakeholder Management :**

In this dimension, we focus on maintaining customer satisfaction, responding to stakeholder expectations and evaluate the whole interaction (relationship) with stakeholders. Support for the project, engagement, commitment, participation in activities and events and stakeholders' perception of value delivered, are some of the key factors measured here.

Customer Satisfaction & Stakeholder Management KPIs include: (Harmantzis , 2018, pp. 15-16)

- Customer Satisfaction Index
- Key Stakeholder Engagement Index
- Contribution to Society, Environmental Preservation
- Energy Efficiency

## **3 Methodological Framework :**

This section outlines the core objectives of the project and details the methodological framework utilized to achieve them. By establishing these parameters, the framework provides a structured approach for analyzing the alignment between strategic goals and operational performance. This analytical foundation ensures that the subsequent

investigation remains coherent, objective, and rigorously aligned with the primary research aims.

### **3.1 Research Approach and Epistemological Posture:**

A constructivist epistemological stance is taken in this study. This decision is motivated by the nature of our problem, which aims to comprehend and enhance the maintenance function's performance a reality created by the interactions, procedures, and resources employed by company actors. Our goal is to comprehend how project management digital tools can be incorporated into maintenance to add value, as opposed to observing a fixed objective truth.

We take an inductive scientific approach in accordance with this stance. We start with particular field observations at Schneider Electric Algeria rather than a strict hypothesis to test. We plan to find trends and extrapolate results from the analysis of qualitative data collected on the ground in order to suggest a structured model for maintenance management through project management principles. ( (SENOUCI , 2018)

### **3.2 Research Methods and Data Collection:**

Methodological triangulation was employed to ensure the validity of our findings. Triangulation is the intersection of three information-gathering tools:

interview, observation, and documentation (SENOUCI , 2018)

#### **3.2.1 Documentary Analysis:**

To comprehend the baseline of maintenance operations and project standards, both internal and external documents were thoroughly examined. Among them at Schneider Electric Algeria were:

- **Internal Maintenance Logs:** Data on equipment failure and effectiveness of interventions.
- **Strategic Reports:** Documents that describe the organization's energy efficiency and operational excellence KPIs.

### **3.2.2 Semi-Structured Interviews:**

To gather in-depth qualitative data, semi-structured interviews were conducted with key project and maintenance personnel. This approach establishes a core set of standardized questions to ensure consistency across all sessions, while offering the flexibility to adapt the line of inquiry based on the respondents' specialized expertise. Consequently, this method captures detailed practical insights regarding maintenance operations and project management processes.

#### **- The Interview Guide:**

Themes such as planning efficiency, tool adoption, and performance barriers were prioritized to ensure all the essential points were covered.

#### **- Target Profiles:**

- Technical Experts familiar with the energy sector context.
- Project Managers.
- Planning Managers.

### **3.2.3 Participant Observation:**

As an active participant within the organization, participant observation was utilized as a data collection tool. Being immersed in the daily environment of the maintenance and project teams allowed for a deep understanding of:

- The actual workflow of maintenance interventions.
- The real-world challenges faced when using (or lacking) project management software.
- The communication flow between technical teams and management.

This "insider" position was crucial for identifying the gap between theoretical procedures and practical execution.

### **3.2.4 Results Analysis :**

an objective analysis method was used to guarantee the validity of the qualitative data collected during the interview phase, this process followed 3 stages: Data transcription, information coding, and data processing. (SENOUCI , 2018)

#### 3.2.4.1 Data Transcription :

In the first stage the oral recordings were transformed systemically, every and each interview was transcribed manually to maintain the transparency of the participants answers, to prevent any interpretation or modification of the interviewees perspectives we used a «word-for-word" method.

#### 3.2.4.2 Information Coding :

to classify the transcribed data an Open Coding (Codage Ouvert) method was applied. Unlike a closed approach which relies on pre-established hypotheses, this inductive method – widely used in industrial research (SENOUCI , 2018) - allowed the analytical grid to emerge directly from the field data. The process involved:

- **Line-by-line review:** carefully reviewing the text to find common patterns and general concepts.
- **Categorization:** Putting related concepts in groups and contrasting various discourse segments to form logical sets.
- **Selective coding:** is the process of determining the fundamental aspects and common patterns that define project management procedures and maintenance performance in the context under study. (SENOUCI , 2018)

#### 3.2.4.3 Data Processing :

For the final analysis stage, a Semantic Treatment was conducted in keeping with the qualitative nature of this study, while statistical processing provides numerical insights, The semantic linguistic approach concentrates on the empirical depth of the ideas expressed. (SENOUCI , 2018)

**Manual Interpretation:** In order to maintain a close connection with the finer points of the participants' professional language, the analysis was done manually.

**Thematic Analysis:** By focusing on the meaning behind specific words and phrases, this treatment allowed for a comprehensive understanding of the qualitative variables affecting project management tools in the energy sector.

## **CHAPTER II: RESULTS AND DISCUSSION**

# 1 Organizational context

In this part we present the organizational context of Schneider Electric corporation and its local representative Schneider Electric Algeria.

## 1.1 Company Presentation :

Schneider Electric is a French multinational corporation. With operations in over 100 countries and a huge network of hundreds of subsidiaries (filliales), including well-known businesses like APC, AVEVA, and ASCO, the corporation continues to have a significant global presence as of 2026. The operation began in 1836 when the brothers Adolphe and Joseph-Eugène Schneider purchased the Le Creusot ironworks. In 1838, Schneider & Cie was established. The company was first established in the heavy industries of steel and locomotives, but in the late 19th century, it made a notable transition to the electrical sector. In order to help it become a digital-first leader in industrial automation and AI-driven cooling for data centers, it has recently made significant investments in software-defined automation. (Schneider Electric, 2026)

### 1.1.1 Presentation Of Schneider Electric Algeria:

For more than 50 years, Schneider Electric has maintained a strong presence in Algeria through a variety of brands. S.E.A. is a major regional player that specializes in offering cutting-edge solutions for infrastructure development, industrial automation, and energy management.

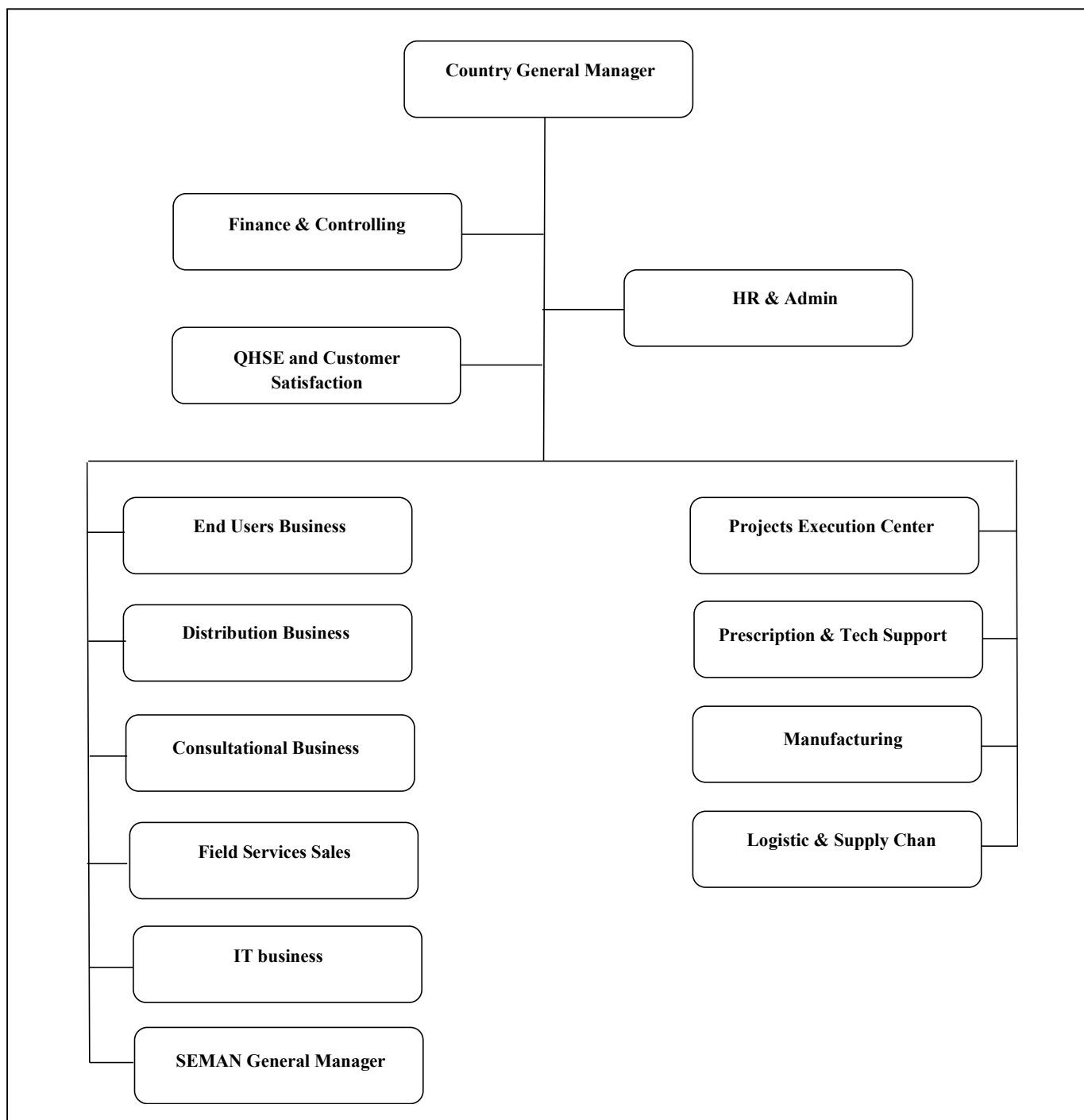
SEA represents :

- Une équipe de 238 collaborateurs ;
- 4 regional agencies (Alger, Oran Hassi Messaoud et Sétif) ;
- Specialized Divisions: Projects and Services;
- 40 certified partners, including distributors, switchboard manufacturers, and system integrators.;
- A specialized manufacturing site dedicated to the assembly of SM6 Medium Voltage (MV) switchgear.;
- local distribution center supported by a 2,500 m<sup>2</sup> warehouse facility.;
- training institute for professional skill-building.
- SEA Center of Excellence, established in 2014 through a bilateral agreement between the French and Algerian (ABDELATIF, 2017)

## 1.2 Organizational chart:

This figure down below represents the Organizational chart of SEA made based on the internal documents of SEA.

**Figure 2:Organizational chart of SEA.**



**Source:** Internal document of SEA.

## 2 Results:

This part is devoted to the project presentation, which the case study is made based on, made by the project team of Schneider Electric Algeria.

### 2.1 Presentation :

#### 2.1.1 Project Overview of Oran Port Penetrating Road to the East–West Highway:

The penetrating road linking Oran Port to the East–West Highway is a major 26-km expressway designed to ease traffic congestion, improve logistics efficiency, and provide a direct connection between one of Algeria’s largest commercial ports and the national highway network.

This strategic project includes major civil engineering structures such as tunnels, cut-and-cover sections, viaducts, and a maritime access road. The works were awarded to the Algerian-Turkish group MAKYOL, and the project is considered one of the most significant infrastructure operations in the country. (Schneider Electric Algeria, 2026)

##### 2.1.1.1 Key Objectives :

The project is designed to transform the transportation framework of the Oran region through five core objectives (Schneider Electric Algeria, 2026):

- **Alleviate Urban Congestion:** Relieves the metropolitan road network of Oran by diverting between 1,600 and 1,800 heavy-duty trucks daily, which currently transit through the city center from the port. This reduces urban deterioration, noise pollution, and vehicular delays.
- **Accelerate Logistics Flows:** Improves the throughput of import and export operations by reducing transit times for shipping containers and cargo, directly benefiting industries and logistics hubs.
- **Establish a Direct and Modern Connection:** Provides a high-capacity, 2×3 lane motorway link that bridges the Port of Oran with the East-West Highway, bypassing urban bottlenecks.
- **Support Economic Development:** Stimulates industrial growth across major hubs in the region, including Béthioua, Oued Tlélat, and Canastel, by ensuring reliable and rapid freight transport.

- **Modernize Regional Mobility:** Upgrades the overall transport infrastructure to meet current engineering standards, enhancing road safety and transit efficiency for both passenger and commercial vehicles.

#### 2.1.1.2 Major Technical Characteristics:

The 26-kilometer motorway features a variety of complex civil engineering structures designed to traverse challenging topography and coastal conditions. The primary technical elements include (Schneider Electric Algeria, 2026):

- **Engineering Structures:** Integration of five major engineering works, including elevated roadways and reinforced retaining structures.
- **Cut-and-Cover Sections:** Two distinct cut-and-cover sections measuring 930 meters and 1,580 meters respectively, which allow the highway to pass beneath urban or sensitive areas without disrupting surface activities.
- **Viaduct Section:** A 680-meter viaduct that spans uneven terrain and natural obstacles, ensuring a continuous, grade-separated alignment.
- **Twin-Tube Tunnel:** A 1,590-meter twin-tube tunnel that provides unidirectional traffic separation, increasing throughput and enhancing safety in the event of an emergency.
- **Maritime Protection and Coastal Roadway:** A 1,600-meter protective sea dyke paired with a dedicated roadway built above the sea to shield the infrastructure from wave action while maintaining coastal connectivity.
- **Highway Interchanges:** Multiple modern, multi-level highway interchanges designed to facilitate smooth transitions and high-speed merging between the port link and local networks.

#### 2.1.1.3 Schneider Electric Algeria's Contribution to the Project:

Schneider Electric Algeria served as a cornerstone technical partner in the electrical engineering phase of the Oran Port motorway project, delivering a high-performance Medium Voltage (MV) ecosystem specifically engineered to meet the stringent safety and uptime demands of underground and maritime infrastructure. To ensure the operational integrity of the 1,590-meter twin-tube tunnel and various cut-and-cover sections, Schneider Electric deployed its SM6-24 10kV modular switchgear across a strategic network of delivery, cut-and-cover, and secondary substations. This SF6-insulated technology provides essential switching and circuit protection, utilizing advanced vacuum breaking

techniques to guarantee high dielectric strength and reliability. By establishing a robust MV distribution backbone, the system ensures continuity of service for life-safety systems—such as high-pressure ventilation turbines, emergency lighting, and fire suppression pumps—where even a transient power loss could jeopardize motorist safety.

Beyond hardware delivery, the collaboration was defined by a rigorous Technical Assistance and Life-Cycle Support framework. Schneider Electric’s engineering teams provided persistent on-site oversight during the complex construction phases, facilitating the seamless commissioning and energization of the MV equipment to prevent insulation faults or thermal anomalies. This proactive approach extended into the operational phase through structured preventive maintenance protocols during the warranty period, optimizing the Mean Time Between Failures (MTBF) for the electrical components. Furthermore, the integration of these MV systems into the project’s SCADA (Supervisory Control and Data Acquisition) platform allows for sophisticated Real-Time Monitoring and remote command capabilities. By utilizing digital twin diagnostics and automated fault-detection logs, operators can perform predictive maintenance and rapid remote switching, significantly enhancing the operational availability, safety, and long-term resilience of Oran’s most critical transport artery. (Schneider Electric Algeria, 2026)

#### **2.1.1.4 Progress & Implementation Status:**

The infrastructure development of the Oran Port to East-West Highway motorway connection has reached an advanced stage, with overall completion currently evaluated at 94% to 95%. This high percentage of completion indicates that the primary civil engineering works and heavy structural elements are largely in place. Key milestones achieved during this phase include the structural finalization of the 1,590-meter twin-tube tunnel, the construction of the 1,600-meter maritime protective sea dyke, and the stabilization of complex geotechnical zones prone to landslides.

The execution strategy relies on a phased commissioning framework, which was scheduled across 2023 and 2024. This incremental approach to project handover is a deliberate risk mitigation measure used in large infrastructure projects. By dividing the 26-kilometer alignment into distinct operational sections, project management teams can test electromechanical equipment, ventilation, and safety systems in smaller, controlled environments before opening the entire route to commercial and civilian traffic.

Furthermore, this stage of completion corresponds with the final integration of the medium-voltage (MV) electrical distribution networks and SCADA remote supervision platforms. Ensuring the reliability and cybersecurity of these systems is critical before full-scale operation begins. Reaching the 95% threshold positions the project to meet its strategic objectives: diverting 1,600 to 1,800 heavy-duty trucks daily from the Oran city center, accelerating the transit of import and export logistics flows, and providing a direct economic link to the industrial zones of Béthioua, Oued Tlélat, and Canastel. (Schneider Electric Algeria, 2026)

#### **2.1.1.4.1 Economic Benefits :**

The construction of the 26-kilometer highway link generates significant macroeconomic advantages by optimizing supply chain logistics and reducing the Generalized Cost of Transport (GCT).

- **Logistics and Cost Reduction:** By providing a direct, high-capacity route that bypasses urban bottlenecks, the infrastructure minimizes vehicle operating costs and reduces transit times for commercial freight. The elimination of delays associated with inner-city transits lowers fuel consumption and reduces wear and tear on heavy-duty vehicles.
- **Competitiveness of Oran Port:** The direct connection enhances the throughput capacity and strategic position of the Port of Oran. Faster clearance and distribution times improve the port's competitive advantage within the Mediterranean maritime network, transforming it into a more attractive hub for international trade.
- **Industrial Zone Connectivity:** The link establishes reliable access to major economic and industrial poles, including Béthioua, Oued Tlélat, and Canastel. This connectivity facilitates the "just-in-time" supply chains required by heavy industries, reduces inventory holding costs, and stimulates regional economic development. (Schneider Electric Algeria, 2026)

#### **2.1.1.4.2 Urban & Social Benefits :**

Beyond financial returns, the project provides substantial social and environmental dividends by reallocating space and reducing negative transport externalities in metropolitan Oran. (Schneider Electric Algeria, 2026)

- **Congestion Alleviation:** The diversion of 1,600 to 1,800 heavy-duty trucks daily from the urban core significantly relieves pressure on the local road network, reducing traffic density and improving the level of service (LOS) on urban thoroughfares.
- **Environmental Improvement:** The reduction in heavy-duty vehicle traffic within residential and commercial zones leads to a measurable decrease in greenhouse gas emissions and localized air pollutants. Furthermore, it mitigates acoustic pollution and decreases the rate of urban pavement degradation.
- **Enhanced Safety and Mobility:** By segregating freight transit from local commuter traffic, the project lowers the probability of severe accidents. It modernizes mobility standards across the region, ensuring safer conditions for both civilian motorists and commercial operators.

#### 2.1.1.4.3 Technical Advancement :

The project serves as a technical benchmark for future infrastructure developments in Algeria, showcasing advanced civil and geotechnical engineering solutions. (Schneider Electric Algeria, 2026)

- **Complex Engineering Integration:** The alignment required the execution of diverse and challenging engineering works. Key components include the 1,590-meter twin-tube tunnel, a 1,600-meter protective maritime sea dyke, cut-and-cover sections, and extensive viaducts.
- **Geotechnical Stabilization:** To construct the roadway through unstable terrain prone to landslides, engineers implemented advanced stabilization techniques, including deep foundations, anchored retaining walls, and soil-improvement measures.
- **Resilience and Safety Standards:** The project incorporates modern electromechanical systems, including intelligent transport systems (ITS), medium-voltage power distribution, SCADA monitoring, and rigorous ventilation and safety systems, ensuring high operational reliability and long-term infrastructure resilience.

#### 2.1.1.5 SPA MAKYOL – Schneider Electric Algeria: Contractual Agreement:

The Oran Port penetrating road represents a major strategic initiative aimed at modernizing regional mobility, enhancing logistics efficiency, and stimulating economic growth. Spanning critical sections of the Oran corridor, the development requires not only advanced civil engineering but also highly resilient electromechanical infrastructure. While

SPA MAKYOL served as the general contractor overseeing the execution of the civil works, the operational viability and safety of the electrical architecture are attributable to the specialized supply and integration provided by Schneider Electric Algeria.

#### **2.1.1.5.1 Contractual Parties and Responsibilities :**

- **Contracting Parties:** The agreement positions SPA MAKYOL as the prime client/contractor managing the overarching civil and structural engineering, while Schneider Electric Algeria acts as the specialized vendor and technical supplier.
- **Scope of Supply:** The contract covers the manufacturing, delivery, testing, and commissioning of MV electrical equipment specifically designed to meet the rigorous safety and continuous-uptime requirements of modern highway corridors and tunnel networks. (Schneider Electric Algeria, 2026)

#### **2.1.1.5.2 Contract Purpose:**

The purpose of the contractual agreement between SPA MAKYOL and Schneider Electric Algeria is to establish a robust, high-availability electrical infrastructure framework for the Oran Port penetrating road project. This section outlines the strategic objectives of the contract and elaborates on Schneider Electric Algeria's long-term technical contributions to the operational reliability of the corridor. (Schneider Electric Algeria, 2026)

#### **- Supplied Equipment:**

The supply of equipment within the framework of the agreement between SPA MAKYOL and Schneider Electric Algeria is designed to deliver a complete medium-voltage distribution infrastructure. According to the technical specifications, the deliverables encompass the SM6-24 10 kV Medium Voltage (MV) switchgear, which includes versatile functional units such as incoming, outgoing, metering, protection, and reserve modules to ensure network flexibility and operational selectivity. To guarantee the reliability of the control, monitoring, and signaling circuits during transient grid disturbances, the scope of supply includes 48 VDC rectifiers and chargers that provide a stable, uninterruptible direct current auxiliary source. Furthermore, the provision of critical safety equipment aligns with international standards for electrical hazard mitigation, while the inclusion of mandatory Factory Acceptance Tests (FAT) and detailed quality inspections ensures that all components satisfy performance and safety thresholds prior to on-site delivery.

**- Excluded Equipment / Services:**

To optimize cost efficiency and maintain a strict division of engineering responsibilities, specific equipment and services are explicitly excluded from the scope of Schneider Electric Algeria. The contract stipulates that all physical on-site installation works, civil engineering infrastructure, and architectural modifications remain the sole responsibility of the general contractor. In addition, low-voltage (LV) works, bulk electrical materials such as cables and cable trays, and compensation batteries are excluded from the supply agreement, requiring careful coordination with parallel project packages. The exclusion of spare parts from the initial delivery also necessitates proactive operational planning by the asset owner to guarantee long-term maintainability. By clearly delineating these boundaries, the contractual framework prevents scope creep, allowing the supplier to focus on specialized medium-voltage components and quality assurance. (Schneider Electric Algeria, 2026)

**- Execution Terms & Deadlines:**

The execution terms and deadlines are structured to balance efficient manufacturing lead times with rigorous engineering review processes. The baseline execution period is set at 14 weeks, which commences following the contract effective date and the final approval of technical drawings. To prevent project bottlenecks, the client is allocated a two-week window to review and approve the submittals. Furthermore, the execution schedule incorporates a risk-allocation mechanism to account for external disruptions; if delays occur that are not attributable to the supplier such as logistical bottlenecks or civil engineering delays on-site Schneider Electric Algeria is entitled to a proportional extension of the deadline. This provision protects both parties and ensures that the manufacturing and supply phases proceed without compromising equipment quality. (Schneider Electric Algeria, 2026)

**2.1.1.5.3 Financial Conditions and Guarantees :**

The financial framework of the agreement is structured to balance cash flow requirements with risk allocation between the contracting parties. It requires a 30% advance payment, which is secured by an advance refund guarantee to mitigate early-stage financial exposure for the client while providing the supplier with the necessary working capital to initiate procurement. The remaining 70% is settled on a pro-rata basis upon the declaration of

Material Available for Dispatch Unpacked (MADU) at the Sidi Rached manufacturing facility, ensuring that payments correspond directly to production milestones. To further safeguard the client's investment, a 10% performance and quality guarantee is retained, ensuring that the delivered medium-voltage equipment meets the requisite technical specifications prior to final operational integration. (Schneider Electric Algeria, 2026)

#### **2.1.1.5.4 Storage Conditions :**

To prevent logistical bottlenecks and ensure the efficient rotation of inventory at the Sidi Rached production site, the contract enforces a stringent storage policy. If SPA MAKYOL fails to collect the manufactured equipment within the agreed timeframe, a grace period of 15 days post-MADU is granted without penalty. Beyond this period, progressive liquidated damages for storage are applied—ranging from 1% after one month to 5% for delays exceeding three months. The underlying logic of this progressive scale is to incentivize timely logistics management, thereby protecting the manufacturer's warehouse capacity and ensuring the smooth flow of subsequent production batches. (Schneider Electric Algeria, 2026)

#### **2.1.1.5.5 Ownership Retention and Transfer of Risks:**

The transfer of risk and ownership is delineated to maintain legal and financial security for the supplier throughout the delivery phase. Ownership of the medium-voltage equipment remains strictly vested in Schneider Electric Algeria until the final financial settlement is received, serving as a security interest against non-payment. Conversely, the transfer of risk occurs upon physical delivery, shifting the responsibility for on-site handling, storage, and potential transit damages to the client. This dual mechanism ensures that while the vendor retains the legal title, the operational liability is appropriately assumed by the receiving party once the equipment is transferred. (Schneider Electric Algeria, 2026)

#### **2.1.1.5.6 Provisional Acceptance and Warranty :**

Provisional acceptance serves as the formal milestone signifying that the equipment has passed all regulatory and functional checks. The process requires a jointly signed acceptance report, which is executed following the completion of testing or a maximum of 60 days post-delivery to prevent protracted acceptance periods. The subsequent 24-month warranty period covers any design, manufacturing, or material defects, providing the client

with operational security. However, the warranty explicitly excludes damages arising from misuse, improper storage, unauthorized modifications, or force majeure events, thereby protecting the manufacturer from liabilities outside its operational control. (Schneider Electric Algeria, 2026)

#### **2.1.1.5.7 Variations :**

The contract establishes a rigorous procedure for variations to control scope creep and manage modifications effectively. Any deviation from the agreed-upon technical specifications or contractual scope must be formalized through a written notification. This variation then undergoes a joint technical and commercial evaluation to assess the impact on cost and delivery timelines. Once agreed, the modification is validated through a signed formal amendment, ensuring transparency and preventing unilateral alterations that could disrupt the execution schedule. (Schneider Electric Algeria, 2026)

#### **2.1.1.5.8 Responsibilities and Penalties :**

To manage exposure and incentivize performance, the agreement establishes a clear framework of liabilities and liquidated damages. Schneider Electric Algeria's overall liability is capped at the total contract value, a standard provision in high-tech industrial contracts that limits disproportionate financial damages. For delivery delays not attributable to force majeure, a penalty of 0.5% per week, up to a maximum cap of 5%, is enforced. Conversely, the contract protects the supplier against client default by allowing the suspension of obligations in the event of late payment, with possible termination rights possible if non-payment persists beyond 90 days. (Schneider Electric Algeria, 2026)

#### **2.1.1.5.9 Suspension, Termination, and Force Majeure :**

The contract outlines mechanisms for both suspension and termination to address unforeseen disruptions. In the event of a client-caused suspension, the client is required to cover all resulting direct and indirect costs incurred by the supplier. Should termination become necessary, the client remains liable for all equipment already delivered, as well as the documented costs associated with the production of pending equipment. Furthermore, the force majeure clause accounts for severe, unforeseeable disruptions—such as pandemics, natural disasters, or governmental actions—and stipulates that if the

impediment lasts for more than 90 days, either party holds the right to terminate the agreement without standard breach penalties. (Schneider Electric Algeria, 2026)

#### 2.1.1.5.10 Governing Law and Dispute Resolution:

To ensure legal predictability, the contract is governed by Algerian law, with the Algiers Court designated as the competent jurisdiction for legal disputes. However, to prioritize commercial efficiency and maintain professional relationships, the contract mandates an initial period of amicable settlement before any escalation to litigation. This mandatory pre-litigation phase reflects a collaborative approach to conflict resolution, reducing the likelihood of costly and prolonged legal proceedings. (Schneider Electric Algeria, 2026)

**Table 1: Breakdown of Contractual Responsibilities and Obligations**

| Topic                  | Schneider Electric (Supplier)                                       | SPA MAKYOL (Client)                                                   |
|------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------|
| Equipment Supply       | Supply all MV SM6 equipment, chargers, safety kits, and perform FAT | Verify deliverables, provide approvals, handle all non-included works |
| Delivery Deadlines     | Respect 14-week deadline, except force majeure or client delays     | Approve plans within 2 weeks; delays extend deadlines                 |
| Delivery Penalties     | Pays 0.5%/week (max 5%) if delay is their fault                     | —                                                                     |
| Late Payment Penalties | May suspend obligations; may terminate after 90 days                | Must pay on time; assumes financial impacts                           |
| Ownership & Risks      | Retains ownership until full payment                                | Assume risks upon delivery                                            |
| Storage                | Stores equipment at client's cost after MADU                        | Pays all storage costs if late                                        |
| Warranty               | 24-month warranty (design, manufacturing, materials)                | Must notify defects, allow access, follow usage instructions          |
| Liability Limits       | Liability limited to contract value (excl. tax)                     | —                                                                     |
| Contract Suspension    | May claim all incurred costs; may terminate after 60 days           | Bears all costs if suspension is their fault                          |
| Termination            | Must be compensated for delivered and in-production items           | Must pay all equipment delivered + proven costs                       |
| Force majeure          | Execution suspended; termination possible after 90 days             | Same; mandatory notification                                          |
| Confidentiality & IP   | Owens all plans, designs, and                                       | Must not disclose or modify                                           |

|          |          |                                                       |
|----------|----------|-------------------------------------------------------|
|          | software | documents                                             |
| Disputes | —        | Amicable resolution first;<br>Algiers Court competent |

Source: (Schneider Electric Algeria, 2026)

#### 2.1.1.5.11 RACI Matrix for Project Processes and Activities:

To ensure clear ownership, accountability, and operational alignment between the contracting parties throughout the project lifecycle, a Responsibility Assignment (RACI) matrix has been established. The matrix defines the respective roles of Schneider Electric and SPA MAKYOL across key project processes, categorizing involvement into responsible, accountable, consulted, and informed functions to prevent operational ambiguity and streamline communication. (Schneider Electric Algeria, 2026)

The roles within the matrix are defined as follows:

- **R (Responsible):** The party responsible for executing and performing the task.
- **A (Accountable):** The party with ultimate decision-making authority who validates the completed work.
- **C (Consulted):** The party whose input and expertise are required before finalizing or executing the task.
- **I (Informed):** The party that is kept updated on the progress or decisions made during the process.

**Table 2: RACI Matrix for Project Processes and Activities**

| Process / Activity             | Schneider Electric | MAKYOL | Comments                                          |
|--------------------------------|--------------------|--------|---------------------------------------------------|
| MV Equipment Supply            | R / A              | I      | Supplier provides SM6, chargers, safety kits, FAT |
| Preparation & Sending of Plans | R                  | C / I  | Schneider prepares; MAKYOL reviews                |
| Approval of Plans (2 weeks)    | C / I              | R / A  | Required within 2 weeks; delays extend deadlines  |
| Equipment Manufacturing        | R / A              | I      | Schneider responsible for conformity              |
| FAT Testing                    | R / A              | I      | Included in contract                              |
| Transport to Oran              | R                  | I      | Schneider delivers to site                        |
| Off-loading                    | —                  | R / A  | Excluded from Schneider scope                     |
| Installation & Assembly        | —                  | R / A  | Excluded from Schneider scope                     |

|                          |                            |                              |                                 |
|--------------------------|----------------------------|------------------------------|---------------------------------|
| Storage Management       | R                          | <b>A / Finance</b>           | Storage charged to MAKYOL       |
| Provisional Acceptance   | R                          | <b>A</b>                     | Joint acceptance                |
| Defect Management        | <b>R / A</b>               | <b>C</b>                     | Schneider repairs/replaces      |
| Variations / Changes     | <b>C</b>                   | <b>R / A</b>                 | Requires amendment              |
| Advance Payment (30%)    | <b>I</b>                   | <b>R / A</b>                 | Contract effective upon payment |
| Advance Refund Guarantee | <b>R</b>                   | <b>I</b>                     | Schneider issues guarantee      |
| 70% Remaining Payment    | <b>I</b>                   | <b>R / A</b>                 | Upon MADU milestones            |
| Late Payment Handling    | <b>A / R</b>               | <b>A</b>                     | Termination after >90 days      |
| Delay Penalties          | <b>A</b>                   | <b>I</b>                     | Up to 5%                        |
| Contract Termination     | <b>A</b> (if client fault) | <b>A</b> (if supplier fault) | Contract clause 19              |
| Force Majeure            | <b>A / R</b>               | <b>A / R</b>                 | Termination after 90 days       |
| Confidentiality & IP     | <b>A</b>                   | <b>R</b>                     | IP belongs to Schneider         |
| Dispute Management       | <b>I</b>                   | <b>A</b>                     | Algiers Court                   |

Source: (Schneider Electric Algeria, 2026)

## 2.2 Discussion:

Based on the of three information-gathering tools: Interviews, observation, and documentation . We have identified the following results.

### 2.2.1 Project Planning and Scheduling via MS Project:

The quality of the planning stage is crucial for successful project management in the energy industry. Because it determines how tasks are divided and synchronized over time, this stage is crucial for establishing the operational boundaries of maintenance projects. Planning is the road map for managing high-value assets and mobilizing specialized resources for the Oran Port project. We are able to develop a dynamic operational support system by going beyond basic task lists with the use of Digital Management Tools such as Microsoft Project.

The project manager can reduce risks and avoid delays by:

- determining intricate task relationships (like Finish-to-Start or Start-to-Start)
- estimating exact durations.

Ultimately, a maintenance program's effectiveness is determined by its capacity to optimize resources while strictly adhering to the contractual timeline.

### **2.2.2 Project Schedule development:**

The conduct of this project phase is designed to guarantee that maintenance performance is incorporated into the energy infrastructure's lifecycle from day one. Using MS Project, a strict project management approach is used to accomplish this.

### **2.2.3 Work Breakdown Structure (WBS) and Task Identification:**

The project is structured into a hierarchical Work Breakdown Structure (WBS) in accordance with the standard procedures seen during the internship. The technical dependencies and specialized resources needed for each phase could be clearly seen due to this breakdown . There are eight main functional blocks that make up the project:

- **Phase 1 & 2 : Project Initiation & Procurement :** This started with the "30% Down Payment" (March 11, 2024), followed by technical consolidation.
- **Phase 3 : Engineering and Approval :** A critical 13-day window where plans for the electrical infrastructure are submitted and validated by the client.
- **Phase 4 & 5 : Execution and Factory Testing :** This involved the production of SM6-24 Switchgear and concluded with the Factory Acceptance Test (FAT) on Mai 29, 2024.
- **Phase 6 : Long Lead Procurement :** A specialized parallel track for high-value security equipment and batteries, requiring 70 days of lead time.
- **Phase 7 & 8 : Commissioning and Preventive Maintenance :** The final stages of the project which ensure long-term industrial performance.

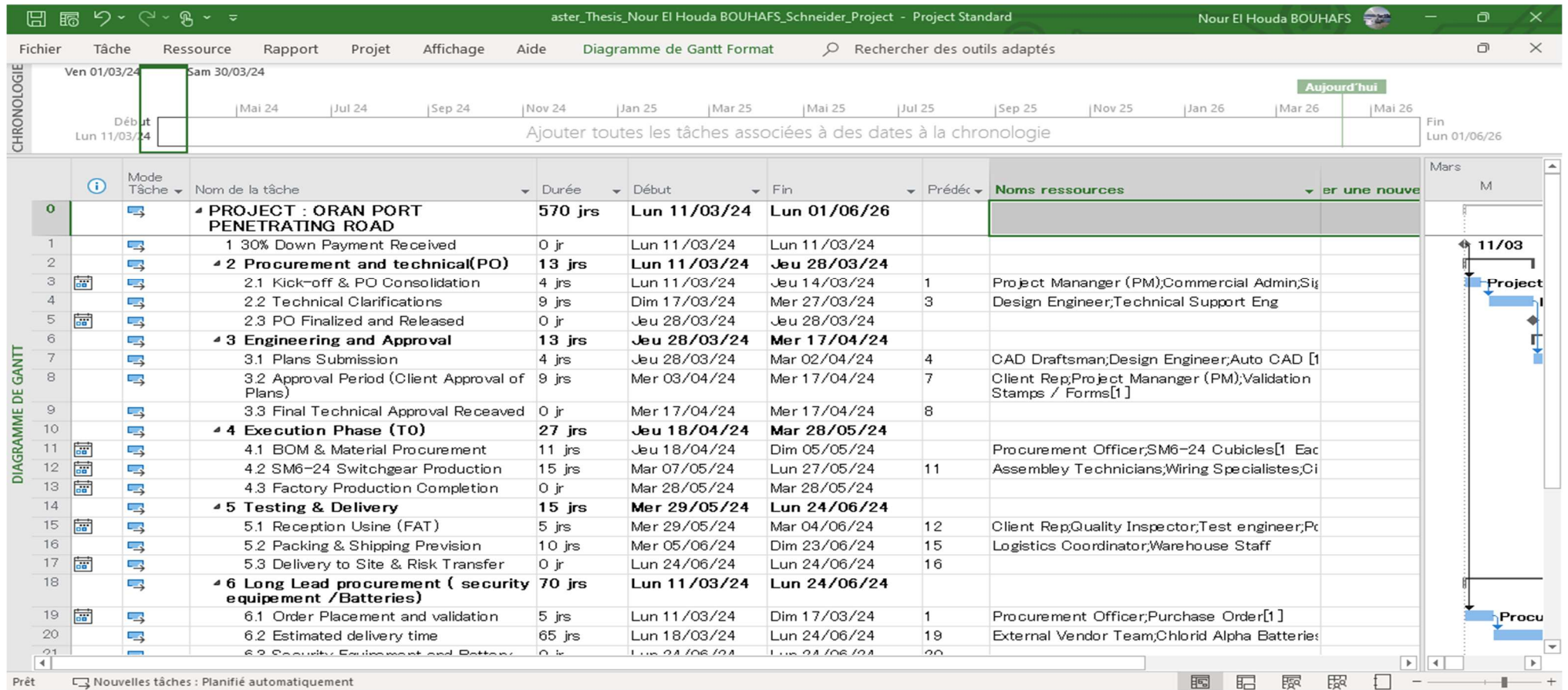
### **2.2.4 Scheduling and Interdependencies:**

Logical interdependencies are used to link tasks in order to master the project timeline. By identifying the Critical Path with MS Project, it was possible to prevent delays in high-priority tasks from affecting other tasks.

**2.2.5 Resource Allocation for Performance Optimization:**

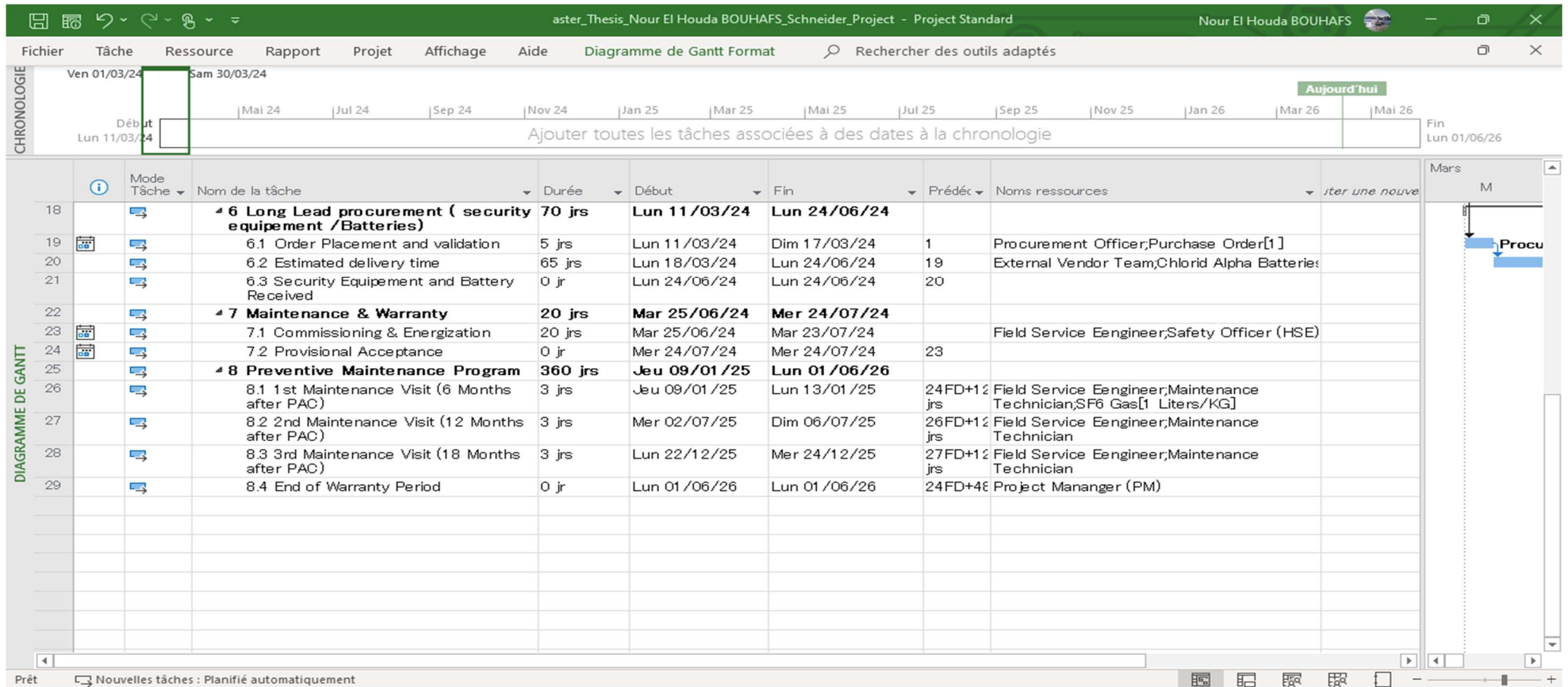
The accurate allocation of specialized human and material resources was a crucial component of this implementation. Each task was associated with a particular area of expertise, as demonstrated by the resource tracking. This ensured that the appropriate skills were available at the precise moment of intervention, thereby decreasing idle time and operating expenses.

Figure 3: Initial project Baseline and Task Sequencing 1



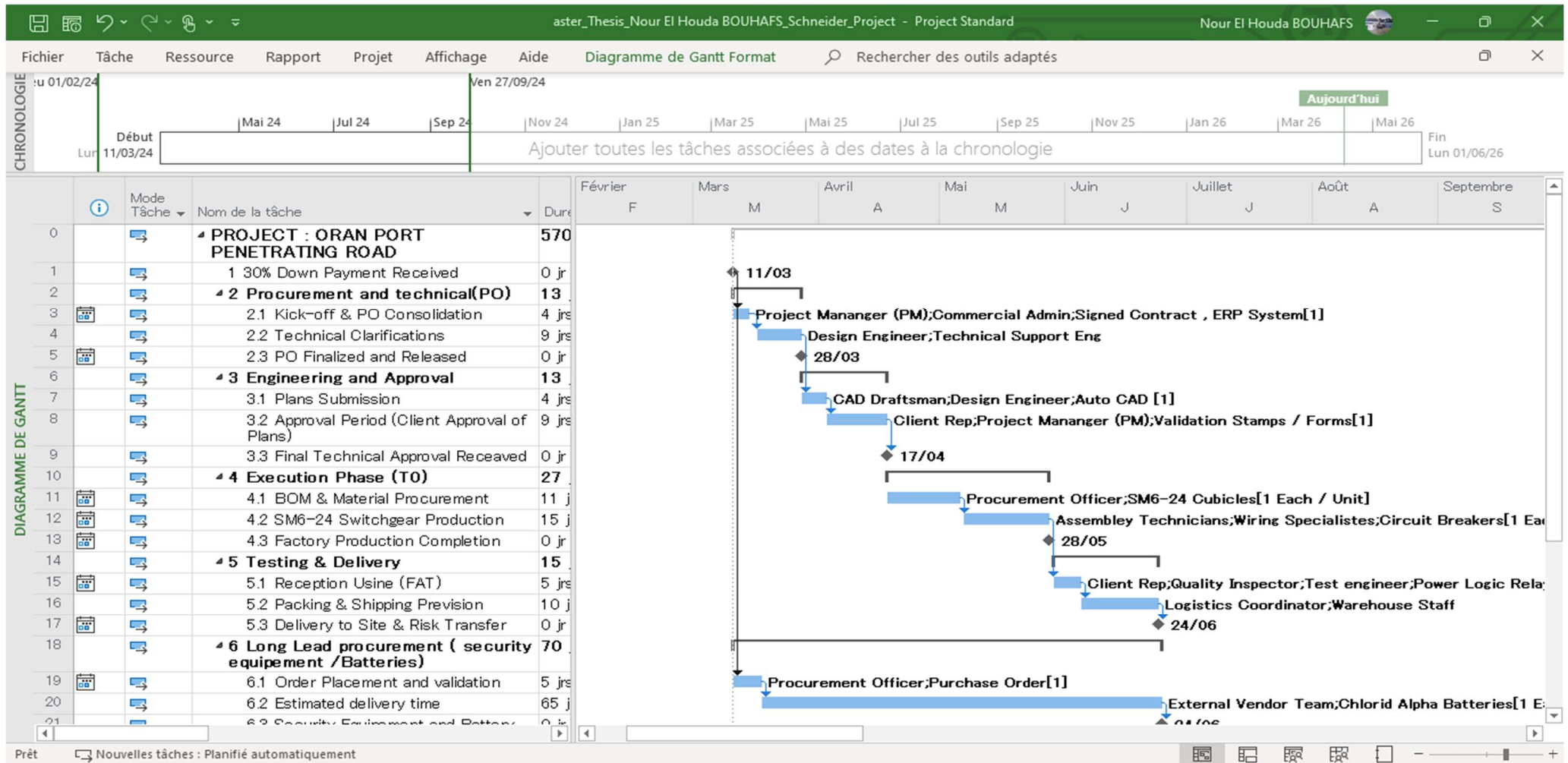
Source: Prepared by the student based on Schneider Electric Algeria internal reports.

Figure 4: Initial project Baseline and Task Sequencing 2



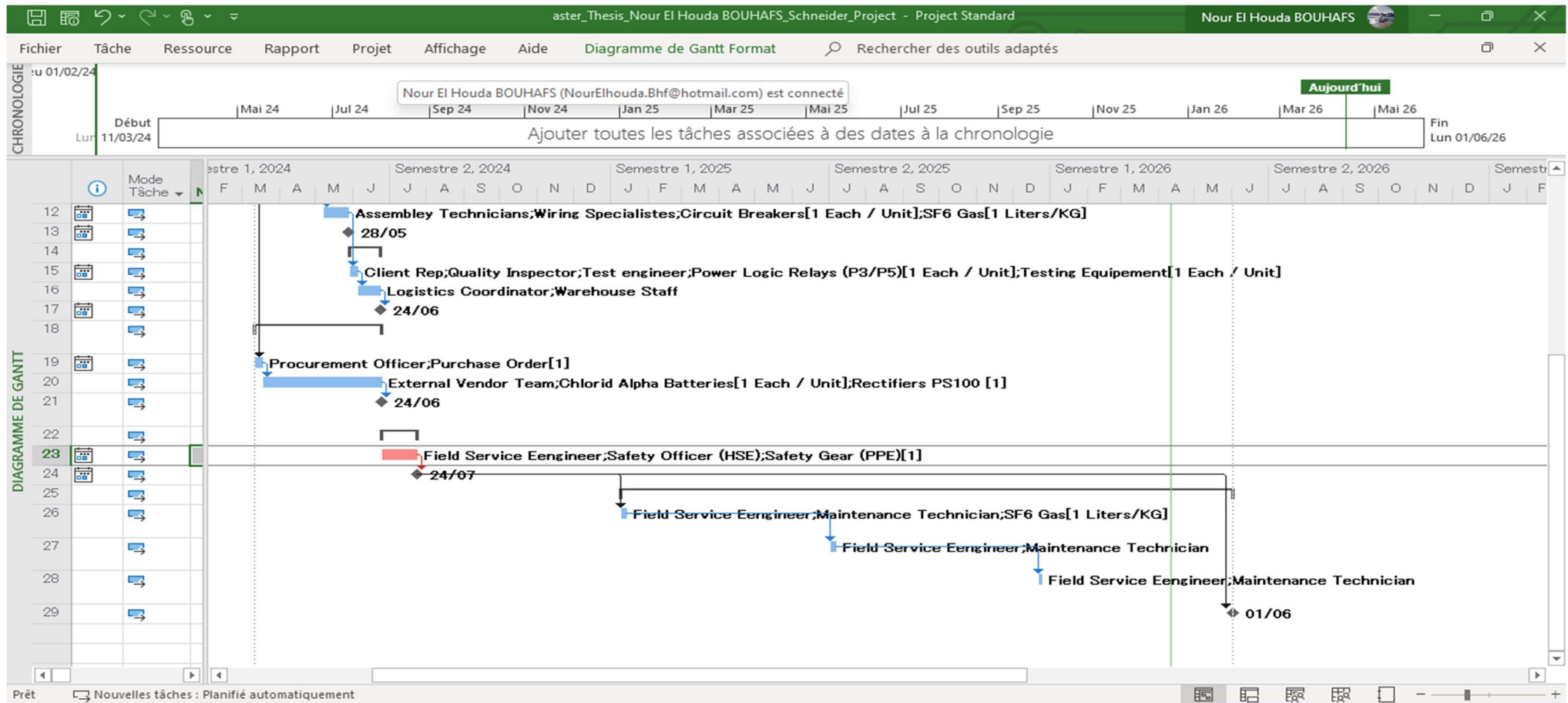
Source: Prepared by the student based on Schneider Electric Algeria internal reports.

Figure 5: Gantt Chart 1



Source: Prepared by the student based on Schneider Electric Algeria internal reports.

Figure 6: Gantt Chart 2



Source: Prepared by the student based on Schneider Electric Algeria internal reports

### **2.2.6 Diagnostic Synthesis:**

This section discusses the data collected from 6 interviewed managers with an experience ranging between 5 and 19 years. The participants included several Project management functions, including Project Managers, Planning Managers, and technical maintenance function managers. The interviews focused on the major problems and perspectives that can affect the maintenance function performance.

#### **2.2.6.1 Process Maturity and Integration:**

The maintenance project monitoring process is governed by a Customer Project Process (CPP), which is divided into three main phases:

- specification and sales phase.
- offer and pricing phase.
- execution phase.

Despite that the process is formalized and integrated for service /maintenance execution project major challenges were identified during the execution phase, specifically:

- Delays in parts supply.
- Difficult site access.
- Reliance on subcontractors.
- Unforeseen emergencies due to critical breakdowns.
- Budgetary constraints for some clients.

#### **2.2.6.2 Critical Pain Points and Digital Gap:**

Most Frequent Problems are related to Aging MV/LV (Medium Voltage/Low Voltage) equipment and circuit breaker defects. Which can cause Extended shutdowns, cost overruns, which require an immediate intervene.

The main components of the toolset are Excel, Microsoft Project and Schneider Electric's ERP systems and Gantt charts to visualize Tasks.

The digital Gap, that is the main reason the digitalization is required which would provide a quicker diagnostic and better traceability (real-time monitoring) and that will result to

Quick schedule modifications and the identification of "priority tasks" to handle delays or shortages.

### **2.2.6.3 Performance Indicator :**

KPIs used for performance tracking by SEA are:

#### **2.2.6.3.1 Failure rate (Taux de panne) :**

The failure rate is a relative expression of the reliability of equipment and each of its components; therefore, it means a quantity that allows us to measure the rate at which failures occur. (Boumaza, 2020, p. 6)

#### **2.2.6.3.2 Availability rate (Taux de disponibilité) :**

It measures the time during which the system is operational and ready to be used. (ANGOUBLO, 2024, p. 6)

#### **2.2.6.3.3 Adherence to deadlines and budgets (respect des délais et budgets.):**

- **Schedule Performance Index (SPI):** The Schedule Performance Index is an earned value management measure that reflects the effectiveness of planned work in progress. (Project Management Institute, Inc., 2021 , p. 195).
- **Cost Performance Index (CPI):** The measurement of earned value management reflects the effectiveness of work in progress relative to its budgeted cost. (Project Management Institute, Inc., 2021 , p. 195)

### **2.2.6.4 Final Diagnosis and Recommendations:**

The diagnosis reveals three top weaknesses that hinder performance:

- **Supply Chain & Logistics:** Delays in parts supply. and difficult site access.
- **Information Silos:** Lack of digitization in certain stages. And Documentation is sometimes scattered.
- **External Dependencies:** high Dependency on customer stock and on subcontractors

### **2.2.6.5 Recommendations:**

To address these operational inefficiencies and improve overall performance, the following recommendations are proposed:

- **Establish a "live" maintenance historical log:** Updating the historical records constantly, so the team has an instant access to the data when needed to make effective diagnosis.
- **Dynamic buffer management in schedules:** work as a strategic technique to protect the schedule from unforeseen situations such as supply chain delays.
- **Advanced MS Project integration:** using MS Project as a dynamic engine for performing steering as it has its resource leveling features for subcontractor management a mapping customer project process.
- **Standardized reporting for MTTR:** create a foundation for real time monitoring, which serves as a bridge between technical field reality and management's performance oversight by standardizing how failure rates and availability are recorded in the ERP systems
- **Implementation of a centralized maintenance management system (CMMS):** based on a staff's recommendation, implementing a digital centralization maintenance data, a platform provide the staff with a stored technical data, guarantee fluid communication between teams and schedule delays.

#### **2.2.6.6 Proposed directions for further study:**

Future research should consider how Artificial Intelligence and Predictive Maintenance (PdM) algorithms can be integrated with scheduling software. Energy companies would be able to transition from static planning to dynamic, automated maintenance ecosystems with this kind of evolution.

## **CONCLUSION**

Throughout this research examined the role of project management digital tools, specifically MS Project, in enhancing the performance of the maintenance function within the energy sector. This study link between traditional maintenance practices and project management methodologies.

This study has demonstrated maintenance interventions from a different angle that allows more control over resources and timelines. We found that scheduling conflicts, which are frequently the main reason for maintenance delays, could be greatly reduced by creating a Work Breakdown Structure (WBS) and using resource leveling. The integration of PM digital tools improves departmental communication and offers a clear roadmap for intricate technical interventions, according to the qualitative analysis of the Six interviews with industry professionals.

This study emphasizes that the "Improvement of Maintenance Function Performance" is a managerial issue rather than just a technical one from a managerial standpoint. Using project management digital tools provide:

**Improved Visibility:** Giving stakeholders access to real-time progress reports on vital energy assets.

**Reducing "dead time"** by identifying overallocated personnel prior to the start of the maintenance cycle is known as optimal resource allocation.

**Data-Driven Decision Making:** Transitioning from a reactive "firefighting" culture to a planned, proactive one.

Despite the favorable results, this study admits some limitations, such as concentrating on a particular organizational setting in Algeria, which could limit how broadly the findings can be applied. Additionally, the human element more especially, the opposition to the digital shift remains a variable that needs more investigation.

Based on the empirical findings, several practical interventions are recommended for industrial managers and planning teams. First, organizations should establish standardized Work Breakdown Structures (WBS) templates for recurring interventions—such as transformer overhauls or circuit breaker replacements—to accelerate scheduling speeds during unexpected operational emergencies. Additionally, formal cross-training programs on digital resource-leveling tools should be implemented for both maintenance supervisors

and project planners to ensure seamless coordination between field realities and administrative schedules. To support this, clear data-entry protocols must mandate strict, daily updates of digital progress logs to prevent documentation backlogs and keep the project's critical path accurate. Finally, planning teams should optimize spare parts buffer management by linking high-probability failure schedules directly with inventory procurement cycles, minimizing delivery bottlenecks before an intervention begins.

By bridging the gap between PdM algorithms and scheduling tools, future research can unlock a new era for energy companies. This transition replaces traditional static models with intelligent, self-optimizing maintenance ecosystems that adapt in real time.

In conclusion, the energy sector is under increasing pressure to be dependable and efficient, making the use of project management digital tools a strategic necessity rather than an option. Businesses like Schneider Electric can guarantee the longevity of their infrastructure and keep a competitive edge in a rapidly changing industrial landscape by turning maintenance into an organized project discipline.

## BIBLIOGRAPHY

### 1. Books

Duffuaa , S., & Raouf, A. (2015). *Planning and Control of Maintenance Systems Second Edition*. Switzerland: Springer International Publishing Springer International Publishing Switzerland 2015 Springer International Publishing Switzerland 2015 Springer International Publishing Switzerland 2015.

Gits, C. W. (1984). *On the design of maintenance concepts of industrial systems*. Technische Hogeschool. Germany: Technische Hogeschool. Doi:10.6100/IR108981

Mubarak, S. (2010). *Construction Project Scheduling and Control Second Edition*. Nex Jersey: Pearson Education, Inc. Consulté le Février 14, 2026

Palmer, R. D. (2006). *Maintenance Planning and Scheduling Handbook, 2nd Edition*. United States: mcgraw-Hill. Doi:10.1036/0071457666

Project Management Institute, Inc. (2021 ). *Guide de Corpus dse connaissances en management de projet GUIDE PMBOOK 7 ème edition*. Newtown Square, Pennsylvania 19073-3299 USA: Project Management Institute, Inc.

Wireman, T. (2005). *Developing Performance Indicators for Managing Maintenance Second Edition*. Newyork: Industrial Press. Consulté le Février 14, 2026

### 2. Articles

Sökmen, Ö. Ç. (2022, Decembre). Critical Path Method with fuzzy activity times. *Journal of Scientific Reports-A*, 371-383. Retrieved Janvier 30, 2026

### 3. Academic works

ABDELATIF, N. (2017). *Dimensionnement et optimisation du nouveau Centre de Distribution* . Mémoire de projet de fin d'études pour l'obtention du diplôme d'Ingénieur d'Etat en Génie Industriel, Ecole Nationale Polytechnique . Consulté le 2026

ANGOUBLO, S. (2024). *Cour Fiabilité des systems industrielle*. Institue International 2i.

Boumaza, F. (2020). *Processus Ponctuels et fiabilité*. Université 8 Mai 1945 Guelma. Guelma: Université 8 Mai 1945 Guelma. Consulté le Avril 2026

Harmantzis , G. (2018). *Project kpis and dashboards Research and Implementation in MS Project*. University of Piraeus . Athens: University of Piraeus . Retrieved Janvier 30, 2026

SAADOUNE, N. (2017). *Contribution à l'amélioration de la fonction maintenance Application : General Electric*. Algerie: Ecole Nationale Polytechnique. Consulté le Février 12, 2026

SENOUCI , M. (2018). *Contribution de la planification dans le management de projet organisationnelles Cas : Projet CIF lafargeholcim*. ÉCOLE NATIONALE SUPÉRIEURE DE MANAGEMENT. KOLÉA: ÉCOLE NATIONALE SUPÉRIEURE DE MANAGEMENT.

#### **4. Reports and administrative documents**

Schneider Electric Algeria. (2026). *Synthèse 01 Oran Port Penetrating Road to the East–West Highway*. Internal project presentation, Alger.

#### **5. Websits**

Schneider Electric. (2026, Février 15). *Schneider-electric-history*. Récupéré sur schneider-electric: <https://www.se.com/dz/fr/about-us/company-profile/history/schneider-electric-history/>

# **APPENDICES**

## **LIST OF APPENDICES**

Appendix A \_Interview Guide.

Appendix B \_Project synthesis.

Appendix C \_SEAMAKYOL Project planning.

Appendix D\_ Interview Analysis Grid.

## **Appendix A \_Interview Guide**

- ## Axe 02 : Processus de gestion des projets de maintenance

3. Les opérations de maintenance sont-elles intégrées au planning général du projet dès le départ ? Pourquoi ?
  
  4. Selon vous, quels sont les principaux défis ou blocages (délais, coûts) rencontrés ?
- 

### **Axe 03 : Problèmes, Impacts et Situations d'Urgence**

5. Quels sont les problèmes de maintenance les plus fréquents rencontrés et quels impacts ont-ils sur les délais, les coûts, la sécurité et la qualité des travaux ?
  
6. Avez-vous déjà connu un arrêt de chantier dû à une panne d'équipement ? Comment gérez-vous ces situations d'urgence ?

#### **Axe 04 : Outils, Ordonnancement et "Scheduling"**

7. Quels supports utilisez-vous pour la planification (Logiciels type **MS Project/Primavera**, ou méthodes type **Excel**) ?
8. Utilisez-vous des outils spécifiques comme le Diagramme de Gantt ou la méthode PERT/CPM ?
9. La maintenance est-elle réellement prise en compte et intégrée dans ces outils de suivi ?
10. Quel est l'apport de ces supports pour minimiser les temps d'arrêt (**downtime**) ?
11. Selon vous, quel serait l'impact d'une digitalisation plus poussée sur le **Mean Time To Repair** (temps de réparation) ?
12. Comment ces outils vous permettent-ils d'anticiper et de gérer les aléas (manque de pièces, retard de personnel, urgences) en cours de projet ?

## **Axe 05 : Pilotage de la Performance et Améliorations**

12. Comment mesurez-vous la performance de la maintenance ou le projet en général: suivez-vous des indicateurs comme le taux de panne, le temps d'arrêt ou les coûts de maintenance ?
  
13. Disposez-vous d'un **système** ou d'un tableau de bord centralisé pour suivre cette performance en temps réel ?
  
14. Quelles sont les principales faiblesses actuelles dans la gestion de la maintenance et que faudrait-il améliorer en priorité ?
  
15. Si vous deviez proposer une amélioration prioritaire pour renforcer le pilotage de la performance de la maintenance chez Schneider Electric, laquelle serait-ce ?
  
16. Quelles bonnes pratiques recommanderiez-vous pour optimiser l'organisation globale ?

**Merci pour votre précieuse collaboration !**

## **Appendix B\_ Project Synthesis**

## Oran Port Penetrating Road to the East–West Highway

### 1. Project Overview

The penetrating road linking Oran Port to the East–West Highway is a major 26-km expressway designed to ease traffic congestion, improve logistics efficiency, and provide a direct connection between one of Algeria's largest commercial ports and the national highway network.

This strategic project includes major civil engineering structures such as tunnels, cut-and-cover sections, viaducts, and a maritime access road. The works were awarded to the Algerian-Turkish group MAKYOL, and the project is considered one of the most significant infrastructure operations in the country.

---

### 2. Key Objectives

- Alleviate urban congestion in Oran, which faces 1,600 to 1,800 heavy trucks daily coming from the port.
  - Accelerate logistics flows for imports and exports.
  - Provide a direct and modern connection between Oran Port and the East–West Highway.
  - Support the economic development of major industrial zones such as Béthioua, Oued Tlélat, and Canastel.
  - Improve transport infrastructure and modernize mobility across the Oran region.
- 

### 3. Major Technical Characteristics

The 26-km roadway includes:

- 5 major engineering structures,
- Two cut-and-cover sections (930 m and 1,580 m),
- A 680-m viaduct,
- A 1,590-m twin-tube tunnel,
- A 1,600-m protective sea dyke and a dedicated road built above the sea,
- Multiple highway interchanges.

The project required advanced construction techniques, particularly to address several landslides along the alignment.

---

#### 4. Schneider Electric Algeria's Contribution to the Project

Schneider Electric Algeria played a key technical role in the electrical infrastructure of the project by delivering a complete Medium Voltage (MV) solution meeting the safety and reliability requirements of tunnels and cut-and-cover sections.

##### Medium Voltage (MV) Supply

Schneider Electric Algeria supplied:

All SM6-24 10kV Medium Voltage switchgear, installed in:

- Tunnel delivery substations,
- Cut-and-cover substations,
- All associated secondary substations.

These MV systems ensure:

- Switching and protection,
- Reliable MV distribution,
- Continuity of service for critical tunnel infrastructure.

##### Technical Assistance & Life-Cycle Support

Schneider Electric also provided comprehensive technical assistance, including:

Continuous on-site technical support during construction,  
Support during commissioning and energization of MV equipment,  
Preventive maintenance follow-ups throughout the warranty period,  
Integration of Schneider Electric MV systems into the project's SCADA supervision platform, ensuring:

- Real-time monitoring,
- Fault diagnostics,
- Remote command and control.

Schneider Electric's contribution significantly enhances the operational reliability, safety, and long-term availability of the road infrastructure.

---

#### 5. Progress & Implementation Status

The project has reached more than 94–95% completion, with phased commissioning scheduled between 2023 and 2024 depending on the sections.

---

##### Economic Benefits

- Reduced logistics and transport costs,

- Increased competitiveness of Oran Port,
- Improved connectivity for industrial zones.

#### Urban & Social Benefits

- Reduced traffic congestion inside Oran,
- Improved environmental conditions with fewer heavy trucks in urban areas,
- Enhanced road safety and mobility.

#### Technical Advancement

- Considered a "reference project" in Algeria, involving complex marine works, tunnels, viaducts, and large-scale civil engineering.

---

#### Summary

The Oran Port penetrating road is a strategic national infrastructure project designed to modernize mobility, support economic growth, and improve logistics efficiency. While MAKYOL led the construction, Schneider Electric Algeria made a decisive contribution by delivering the full Medium Voltage electrical architecture, including SM6 24 kV switchgear, substations, commissioning support, preventive maintenance, and integration with the SCADA system.

This contribution ensures high-performance, reliable, and safe electrical operations across the entire corridor—critical for the long-term functioning of the tunnels and associated infrastructure.

### MAKYOL – SCHNEIDER ELECTRIC ALGERIA CONTRACT:

---

#### 1. Contracting Parties

- Client: SPA MAKYOL
- Supplier: Schneider Electric Algeria
- Project: Supply of Medium Voltage (MV) electrical equipment for the Oran Port – East–West Highway penetrating road (8 km).

---

#### 2. Contract Purpose

##### Supplied Equipment

According to the technical specifications:

- SM6-24 10 kV MV switchgear (incoming, outgoing, metering, protection, reserve...)
- 48 VDC rectifiers/chargers
- Safety equipment
- Factory Acceptance Tests (FAT) & inspections

#### Excluded Equipment / Services

- Installation works on site
  - Civil works, infrastructure, and architecture
  - Low-voltage works
  - Spare parts
  - Cables & cable trays
  - Compensation batteries
- 

#### 3. Execution Terms & Deadlines

- Execution period: 14 weeks after contract effective date + plan approval
  - Client has 2 weeks to approve plans and drawings
  - Delays not attributable to the supplier → deadline extension
- 

#### 4. Financial Conditions

##### Payment Terms

- 30% advance payment (against advance refund guarantee)
- 70% pro-rata upon availability (MADU) at Sidi Rached factory

##### Guarantees

- 30% advance refund guarantee
  - 10% performance/quality guarantee
- 

#### 5. Storage Conditions

If MAKYOL does not collect equipment on time:

- 0% until MADU + 15 days
  - 1% after 1 month
  - 2% after 2 months
  - 5% after 3+ months
- 

#### 6. Ownership Retention & Transfer of Risks

- Ownership: remains with Schneider until full payment
- Risks: transferred to the client upon delivery

---

## 7. Provisional Acceptance & Warranty

### Provisional Acceptance

- Jointly signed acceptance report
- After successful tests or maximum 60 days after delivery

### Warranty

- 24 months from delivery
  - Covers design, manufacturing, and material defects
  - Excludes: misuse, improper storage, unauthorized modifications, force majeure
- 

## 8. Variations

Any change must:

- be formally notified in writing
  - undergo technical & commercial evaluation
  - be validated through a signed amendment
- 

## 9. Responsibilities & Penalties

### Liability Limitation

- Schneider's liability capped at **total contract value**

### Delay Penalties (Delivery)

- 0.5% per week
- Cap: 5% total

### Late Payment

- Suspension of obligations
  - Possible termination after 90 days of non-payment
- 

## 10. Suspension & Termination

### Suspension

If caused by client → client pays all incurred costs.

### Termination

Client must pay:

- All equipment already delivered
- Costs incurred for equipment under production

## 11. Force Majeure

Events: war, pandemic, fire, natural disasters, governmental decisions...

If lasting more than 90 days → contract may be terminated.

## 12. Governing Law & Disputes

- Governing law: Algerian Law
- Competent court: Algiers Court
- Mandatory amicable settlement attempt before escalation

## Comparative Table – Risks & Responsibilities of the project :

| Topic                  | Schneider Electric (Supplier)                                       | SPA MAKYOL (Client)                                                   |
|------------------------|---------------------------------------------------------------------|-----------------------------------------------------------------------|
| Equipment Supply       | Supply all MV SM6 equipment, chargers, safety kits, and perform FAT | Verify deliverables, provide approvals, handle all non-included works |
| Delivery Deadlines     | Respect 14-week deadline, except force majeure or client delays     | Approve plans within 2 weeks; delays extend deadlines                 |
| Delivery Penalties     | Pays 0.5%/week (max 5%) if delay is their fault                     | —                                                                     |
| Late Payment Penalties | May suspend obligations; may terminate after 90 days                | Must pay on time; assumes financial impacts                           |
| Ownership & Risks      | Retains ownership until full payment                                | Assumes risks upon delivery                                           |
| Storage                | Stores equipment at client's cost after MADU                        | Pays all storage costs if late                                        |
| Warranty               | 24-month warranty (design, manufacturing, materials)                | Must notify defects, allow access, follow usage instructions          |
| Liability Limits       | Liability limited to contract value (excl. tax)                     | —                                                                     |
| Contract Suspension    | May claim all incurred costs; may terminate after 60 days           | Bears all costs if suspension is their fault                          |

| Process / Activity             | Schneider Electric  | MAKYOL                | Comments                                          |
|--------------------------------|---------------------|-----------------------|---------------------------------------------------|
| MV Equipment Supply            | R / A               | I                     | Supplier provides SM6, chargers, safety kits, FAT |
| Preparation & Sending of Plans | R                   | C / I                 | Schneider prepares; MAKYOL reviews                |
| Approval of Plans (2 weeks)    | C / I               | R / A                 | Required within 2 weeks; delays extend deadlines  |
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| Force Majeure                  | A / R               | A / R                 | Termination after 90 days                         |
| Confidentiality & IP           | A                   | R                     | IP belongs to Schneider                           |
| Dispute Management             | I                   | A                     | Algiers Court                                     |

---

## Strategic Summary

### Key Responsibilities – Schneider Electric

- Complete supply of MV equipment
- Technical compliance & documentation
- FAT + transport
- 24-month warranty support
- Issuance of guarantees
- Handling technical variations

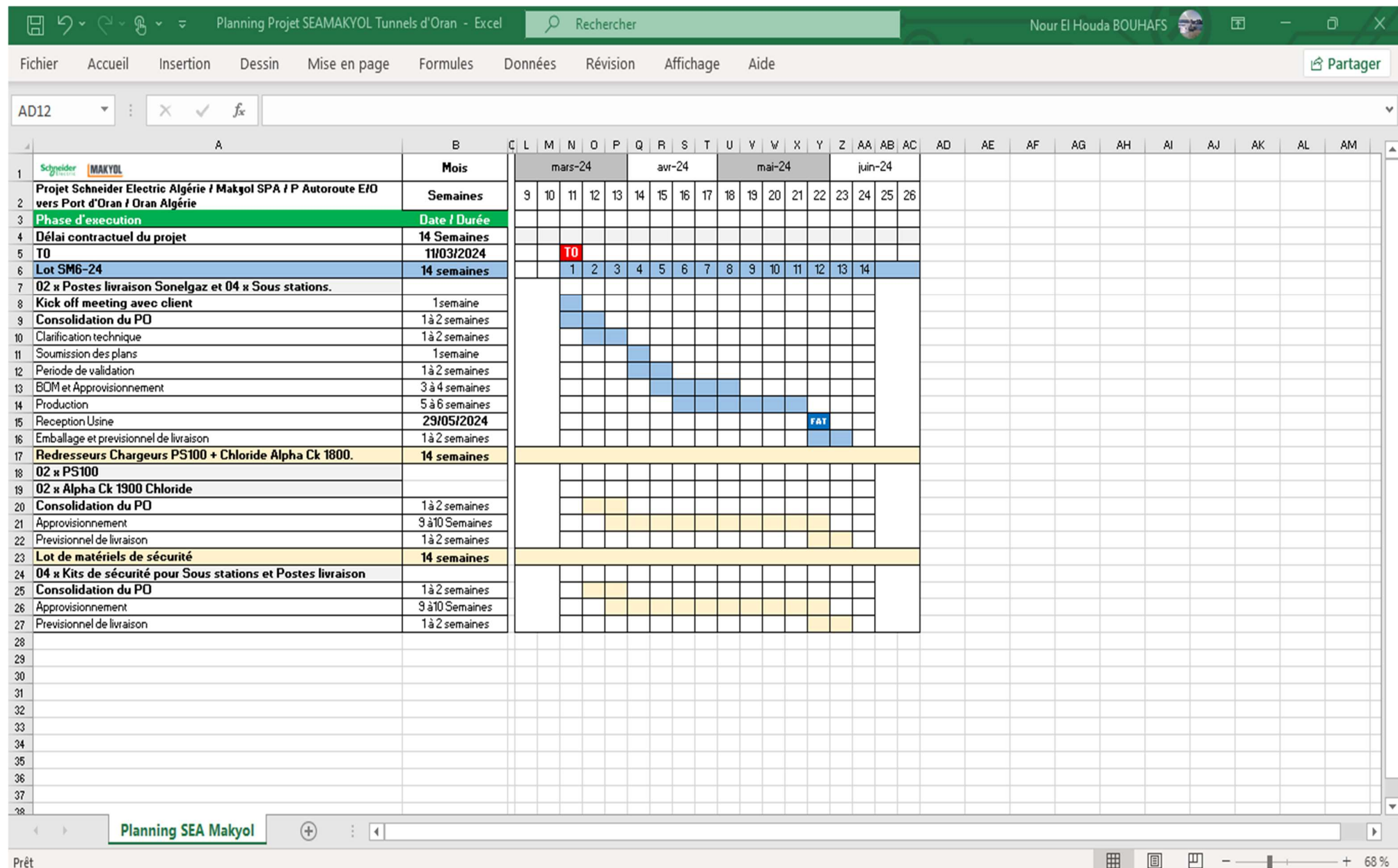
### Key Responsibilities – MAKYOL

- Approving plans (2 weeks)
- Payments (30% + 70%)
- Installation & off-loading
- Provisional acceptance
- Defect notifications
- Providing access & logistics support
- Bearing costs for delays or non-collection

## Summary

The contract commits Schneider Electric Algeria to supplying SM6 MV switchgear and associated MV equipment for the Oran Tunnel project within 14 weeks. Schneider retains ownership until full payment is made. The client must pay a 30% advance, approve plans within the set deadlines, and take responsibility for transport after factory delivery. Warranty is 24 months. Any changes require a formal amendment. Litigation falls under the jurisdiction of the country.

## **Appendix C\_SEAMAKYOL Project Planning**



## **Appendix D \_Interview Analysis Grid.**

|                    | Axe Processus de gestion des projets de maintenance                                                                                                                                                                                                                                                                                                         | Axe Problemes, Impacts et Situation d'Urgence                                                               | Axe Outils, Ordonnancement et Scheduling                                                                                                                                | Axe Pilotage de la performance et Améliorations                                                                                                                |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Entretien 1</b> | Le processus de suivi des projets de maintenance est régi par un processus formalisé dit cpp (Customer Project process), qui se décompose en trois phases, la phase prescription et commerciale, la phase offre et chiffrage, la phase exécution.                                                                                                           | Arrêt de chantier et urgence, cela arrive parfois lors d'une panne critique.                                | Microsoft office Excel et/ou Microsoft office ms Project.<br><br>Nous utilisons des ERP propres au groupe se, et des outils comprenant différentes méthodes d'analyses. | Les ERP d'analyses des projets et les revues cycliques des projets permettent de procéder à des mesures d'anticipation opérationnelles des actions entreprises |
| <b>Entretien 2</b> | Le suivi commence dès la réception de la demande client. Analyse du besoin, préparation de l'offre technique, puis planification de l'intervention avec l'équipe concernée. Suivi de l'avancement de la disponibilité du matériel et la coordination entre l'équipe interne et le prestataire. Enfin, le rapport d'intervention est partagé avec le client. | Vieillesse des équipements MT/BT (moyenne tension / basse tension). Défauts de disjoncteurs ou contacteurs. | Selon le type de projet. Nous utilisons Excel, MS Project et l'outil interne de se, et les diagrammes de Gantt pour visualiser les tâches.                              | Pour mesurer la performance nous utilisons : taux de panne, taux de disponibilité, respect des délais et budgets.                                              |

|                    |                                                                                                                          |                                                                                                                          |                                                                                                                                    |                                                                                                                                     |
|--------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <b>Entretien 3</b> | Se (Schneider Electric) dispose de procédures, guide sécurité, fiche technique pour standardiser la gestion des projets. | Arrêts prolongés, dépassements de coûts.<br>Pannes critiques à cause de retards dans l'approvisionnement des pièces.     | En fonction du projet et de la demande du client, nous utilisons : Excel, ms Project et ERP de se.                                 | Utilise des rapports standardisés et des outils internes.                                                                           |
| <b>Entretien 4</b> | Ce processus cpp est formalisé au sien de se                                                                             | Retards dans l'approvisionnement des pièces.<br><br>Accès difficile au site.<br><br>Vieillessement des équipements MT/BT | On utilise des outils bureautiques.                                                                                                | Analyses des projets par l'ERP.                                                                                                     |
| <b>Entretien 5</b> | Nous utilisons un processus appelé cpp qui comprend 3 phases : prescription, commerciale, et offre et chiffrage.         | Dépendance des st (sous-traitants).<br><br>Urgences imprévues dues aux pannes critiques.                                 | Pour nos projets nous utilisons des outils comme Excel                                                                             | Taux de panne, taux de disponibilité.                                                                                               |
| <b>Entretien 6</b> | La gestion des projets repose sur des guides et fiches techniques                                                        | Contraintes budgétaires pour certains clients.                                                                           | Utilisation des outils divers (ERP, Excel, diagramme de gant.) Permettent de respecter les délais, budget de réalisation de projet | KPIs permettent d'évaluer la fiabilité des équipements : taux de panne, MTTR, taux de disponibilité, respect des délais et budgets. |