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Dedication

First and foremost, praise be to God for guiding my steps throughout this journey.

This work is dedicated to my parents, whose unconditional love, endless sacrifices, and continuous prayers have been the cornerstone of my achievements. They have always been my greatest source of inspiration, and this milestone is as much theirs as it is mine.

To my dear sister, I wish her a lifetime of health, happiness, and well-being.

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To all my friends, and to everyone who has supported me, directly or indirectly, along this path.

- Mohamed Benhamou

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*To my research partner and close friend, **Benhamou Mohamed** Navigating the challenges of this project together has been a privilege, and I could not have asked for a better teammate.*

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- Salah edinne benabdallah

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List of abbreviation

Abbreviation	Meaning
ABM	Account-Based Marketing
API	Application Programming Interface
B2B	Business-to-Business
B2C	Business-to-Consumer
B2G	Business-to-Government
CAPEX	Capital Expenditure
CCO	Chief Commercial Officer
CEO	Chief Executive Officer
CHU	Centre Hospitalier Universitaire
CMMS	Computerized Maintenance Management System
CTO	Chief Technology Officer
DSP	Direction de la Santé et de la Population
EHS	Établissement Hospitalier Spécialisé
EPSP	Établissement Public de Santé de Proximité
ERP	Enterprise Resource Planning
HIS	Hospital Information System
ISO	International Organization for Standardization
KPI	Key Performance Indicator
MTTR	Mean Time To Repair

Abbreviation	Meaning
MVP	Minimum Viable Product
OPEX	Operational Expenditure
PESTEL	Political, Economic, Social, Technological, Environmental, Legal
PoC	Proof of Concept
PR	Public Relations
QR	Quick Response
RBAC	Role-Based Access Control
ROI	Return on Investment
SaaS	Software as a Service
SAM	Serviceable Available Market
SIMEM	Salon International du Matériel et de l'Équipement Médical
SLA	Service Level Agreement
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SOM	Serviceable Obtainable Market
SWOT	Strengths, Weaknesses, Opportunities, Threats
TAM	Total Addressable Market
UI	User Interface
UX	User Experience

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General Introduction

General Introduction

Medical devices are fundamental pillars for the prevention, diagnosis, and treatment of illness within any resilient healthcare system (**World Health Organization [WHO], 2021**). However, in developing nations and the African continent, the effectiveness of these technologies is severely hindered by technical and infrastructural challenges. Recent research highlights that the poor maintenance of digital health equipment and the lack of structured oversight frequently lead to prolonged equipment downtime and disrupt patient care (**Al Meslamani, 2023**). This "Maintenance Gap" is primarily caused by archaic, paper-based reporting mechanisms and a structural communication breakdown between clinical users and technical departments. When critical equipment fails under such traditional management, hospitals face severe operational and financial burdens.

To overcome these systemic failures, recent healthcare management studies strongly advocate for the digitalization of maintenance workflows. Research confirms that replacing manual reporting with robust, web- and mobile-based maintenance management systems ensures prompt fault notification to biomedical engineers and significantly extends the usability and lifetime of medical equipment (**Nwaneri & Olaoye, 2023**). By transitioning to a centralized digital inventory and tracking system, hospitals can drastically reduce the administrative delays associated with equipment repairs and transition from a reactive approach to a proactive maintenance strategy.

Algeria has invested significantly in expanding its healthcare infrastructure over the past two decades. However, this growth has not been matched by a modernization of internal hospital operations. In the majority of Algerian healthcare institutions—both public and private—the process of reporting equipment failures and coordinating maintenance interventions continues to rely on paper-based registers and informal verbal communication. Response times for critical equipment repairs extend from hours to days, maintenance histories are poorly documented, and hospital administrators lack the quantitative data needed to identify recurring failure patterns or evaluate technician performance.

In light of the global trend towards digitalization (**Ministry of Digitization and Statistics, 2023**), Algeria is striving to keep pace with this technological evolution by launching a series of national

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initiatives aimed at digitalizing various vital sectors, with the healthcare sector at the forefront. These efforts fall within a comprehensive strategy aimed at improving the quality of medical services, facilitating citizens' access to healthcare, raising the management efficiency of health institutions, and reducing operational costs. However, despite this strong national momentum toward digital transformation, many healthcare facilities still experience a profound gap between this vision and their daily operational realities. In many hospitals, the process of reporting equipment breakdowns and coordinating maintenance still relies heavily on archaic paper records and informal verbal communication.

It is precisely within this context that our project, E-Signal, is introduced as a targeted solution. E-Signal is a digital platform specifically designed for rapid fault reporting and maintenance tracking, tailored to the Algerian healthcare context. By replacing outdated paper logs with an agile, mobile-first application utilizing QR code technology, E-Signal enables any hospital staff member to report an equipment failure in seconds. The platform automatically routes requests to the appropriate technical department, provides real-time tracking, and equips hospital administrators with data-driven dashboards to monitor performance and transition from reactive to proactive maintenance. More importantly, it paves the way for a transition from strictly reactive repairs to predictive maintenance; by identifying recurring failure patterns, the system helps anticipate breakdowns before they disrupt patient care, all while strictly adhering to national data privacy regulations (Law No. 18-07, 2018).

Furthermore, this project is fundamentally aligned with the strategic vision of the Algerian Ministry of Higher Education and Scientific Research, falling squarely under the framework of Ministerial Decree 1275 ("A Diploma, A Startup") (**Ministerial Decree No. 1275, 2022**). This initiative represents our transition from academic research to practical entrepreneurship, aiming to deliver a viable, socio-economically impactful solution. The central research question guiding this work is: How can a digital fault-reporting platform reduce maintenance intervention response times, improve coordination between medical and technical teams, and enhance the overall quality of services within a healthcare institution? Through field observation, strategic market analysis, and functional prototyping, this thesis aims to demonstrate that E-Signal represents a scalable and financially sustainable entrepreneurial response to a critical systemic challenge in Algeria.

◊ **Axis one: Project Presentation**

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In an ever-changing global landscape, innovation has emerged as a fundamental strategic lever for corporate development, particularly for startups seeking to address contemporary challenges through novel and adaptive solutions. Innovation is no longer confined solely to advanced technologies; rather, it encompasses a comprehensive set of profound transformations affecting business models, work organization, user experience, and social impact (**Tidd & Bessant, 2020**). For a digital startup, innovation represents the bridge between conceptual potential and operational excellence, enabling the disruption of traditional industry paradigms.

In the public health sector, and more specifically within the management and maintenance of hospital infrastructure, innovation takes on a critical dimension. The increasing complexity of medical equipment, coupled with the urgent necessity for high clinical uptime, imposes a mandatory reform of traditional maintenance approaches (**Kraus et al., 2021**). Conventional methods, often reliant on manual logs and fragmented communication, frequently fail to respond effectively to the immediate needs of medical departments, leading to equipment downtime and compromised patient safety. Faced with these limitations, new initiatives like **E-SIGNAL** emerge, leveraging digital technologies, real-time tracking, and organizational process optimization to improve the accessibility, quality, and flexibility of hospital maintenance services (**WHO, 2021**). This chapter explores the innovative nature of our solution and its systemic impact on the healthcare environment.

◇ Axis one : Project Presentation

1- About Idea

1.1 Theoretical Foundation: The Spectrum of Healthcare Maintenance

In healthcare technology management, equipment maintenance is not a monolithic activity but a structured spectrum of progressively sophisticated approaches. Understanding this spectrum is essential to positioning E-SIGNAL within the broader field of hospital operations management.

Corrective Maintenance (Reactive) represents the most basic and, unfortunately, the most prevalent model in resource-constrained settings. Under this approach, interventions are performed only after a breakdown has already occurred. The defining characteristics of corrective maintenance are maximum equipment downtime, elevated repair costs (due to emergency procurement of spare parts), and an inherently unpredictable operational environment. Research across low- and middle-income countries has consistently shown that hospitals operating exclusively within this model experience non-functionality rates averaging 37% of their total equipment inventory (Ssekitoleko et al., 2021).

Preventive Maintenance (Scheduled) introduces a proactive dimension, with planned interventions executed at predetermined intervals based on manufacturer guidelines, equipment age, or usage cycles. This model significantly reduces the probability of unexpected failure and extends equipment lifespan. However, it requires a foundational infrastructure that many developing-world hospitals lack: structured equipment registries, documented maintenance histories, and dedicated technical personnel capable of executing scheduled protocols.

Predictive Maintenance (Data-Driven) represents the most advanced paradigm, utilizing historical operational data, real-time sensor input, and analytical tools to predict and prevent failures before they manifest. This model optimizes maintenance spending by directing resources precisely where and when they are needed, rather than following rigid calendar-based schedules.

Currently, Algerian hospitals predominantly operate within the Corrective (Reactive) spectrum, primarily due to the absence of organized data capture systems. E-SIGNAL is designed to be the transitional vehicle that captures the necessary real-time operational data to move hospital infrastructure from a purely corrective model toward a preventive—and ultimately predictive—maintenance governance framework.

1.2 The CMMS Landscape: Global Solutions & Local Realities

While the concept of Computerized Maintenance Management Systems is well established in high-income healthcare environments, the global CMMS market—valued at approximately USD 211.6 million in 2022 and projected to reach USD 494.9 million by 2030 (Grand View Research, 2023)—is dominated by platforms designed for large-scale industrial and Western hospital contexts.

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International platforms such as **IBM Maximo**, **Fiix**, and **UpKeep** offer robust maintenance tracking capabilities including automated work order management, IoT sensor integration, predictive analytics, and regulatory compliance documentation. IBM Maximo, for instance, is deployed across healthcare systems worldwide as an enterprise asset management (EAM) solution capable of managing the full lifecycle of medical devices from acquisition to decommissioning (IBM, 2024). However, these platforms present significant adoption barriers for Algerian public hospitals:

- **Prohibitive licensing costs** denominated in foreign currency (USD/EUR), incompatible with Algerian public hospital budgets;
- **Mandatory constant internet connectivity** (cloud-reliant architecture), impractical in institutions with intermittent or absent network infrastructure;
- **Complex desktop-first interfaces** requiring extensive IT training, unsuitable for clinical staff operating under time pressure;
- **Absence of localization** for bilingual Arabic-French environments with RTL (right-to-left) layout support.

Nationally, the alternative landscape is equally inadequate. Algerian hospitals either rely on generic ERP systems (such as Odoo) forcefully adapted to healthcare maintenance—without domain-specific features like medical device classification or biomedical vs. general maintenance routing—or revert to **fragmented Excel spreadsheets** and paper registers, which offer no traceability, no notification capability, and no analytical potential.

E-SIGNAL positions itself precisely in this gap by offering a "**Mobile-First, QR-Triggered**" architecture specifically engineered for the constraints and hierarchical realities of the Algerian healthcare environment. Its design ensures zero-friction adoption by non-technical clinical staff while delivering the core CMMS functionalities—work order generation, status tracking, timestamped documentation, and management analytics—that international platforms provide, but at a fraction of the cost and complexity.

1.3 Theoretical Underpinnings: Lean Healthcare and TAM

The conceptual framework of E-SIGNAL is grounded in two established management theories that inform both its design philosophy and its expected adoption dynamics.

Lean Healthcare Management, adapted from the Toyota Production System to hospital operations, focuses on the systematic identification and elimination of "**Muda**" (**waste**)—any activity that consumes resources without adding value to the patient. The lean framework identifies seven categories of waste; E-SIGNAL directly addresses two of the most prevalent in hospital maintenance:

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- **Waiting Waste :** The time medical staff spend waiting for a maintenance response after filing a paper-based report. E-SIGNAL's instantaneous digital notification eliminates this waiting period entirely.
- **Motion Waste:** The physical displacement of staff from their clinical post to a maintenance office to file a report, then the return trip, often repeated for follow-up inquiries. E-SIGNAL's point-and-scan QR interface eliminates all non-value-added physical movement, allowing staff to report a fault from the exact location where it is discovered without leaving their patient care duties.

The Technology Acceptance Model (TAM), originally proposed by Davis (1989) and extensively validated across healthcare technology adoption studies, posits that a system's real-world adoption is primarily determined by two factors: **Perceived Ease of Use** and **Perceived Usefulness**. E-SIGNAL's design decisions are deliberately aligned with both:

- **Perceived Ease of Use** is maximized through the QR-scan interface—requiring no manual data entry, no navigation through complex menus, and no prior technical training. If a staff member can use a smartphone camera, they can use E-SIGNAL.
- **Perceived Usefulness** is reinforced through immediate, visible outcomes: the user sees their ticket acknowledged within seconds, can track its progress in real time, and receives confirmation when the repair is complete. This feedback loop validates the system's utility with every interaction.

By grounding E-SIGNAL in these theoretical frameworks, the project moves beyond a purely technical proposition into a management intervention with demonstrable academic foundations—a distinction that is critical for a Healthcare Management thesis.

1.4 Definitional Essence: E-SIGNAL as a Healthcare CMMS :

The "E-SIGNAL" initiative represents more than a simple notification tool; it is a specialized **Computerized Maintenance Management System (CMMS)** tailored for the complex hospital environment. A CMMS is a software platform that centralizes maintenance information—including equipment inventories, work orders, preventive maintenance schedules, and repair histories—into a single, auditable system. Research on sustainable medical equipment maintenance in under-resourced healthcare settings has demonstrated that the absence of such systems is a primary driver of equipment non-functionality, as facilities without structured digital tracking remain trapped in informal, reactive maintenance cycles that accelerate equipment degradation (Webber et al., 2020).

E-SIGNAL fulfills this role by assigning a **unique digital identity** (via QR Code) to each hospital asset—whether a fetal monitor in the maternity ward, a central air conditioning unit, or a network printer in the administration office. This transforms the hospital's physical infrastructure into a

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manageable digital database in which every device possesses a traceable lifecycle record: its specifications, location (department → room → bed number), maintenance history, and current operational status. This architecture enables automated work-order generation, eliminates manual transcription errors, and provides what the literature terms a robust framework for **asset governance**—the systematic oversight of equipment from acquisition through decommissioning.

What distinguishes E-SIGNAL from generic commercial CMMS platforms—which are typically designed for industrial manufacturing settings—is its deliberate adaptation to the **operational realities of Algerian healthcare institutions**. These realities include: bilingual Arabic-French working environments; intermittent or absent internet connectivity (necessitating offline capability with automatic synchronization); hierarchical departmental structures that separate biomedical engineering from general maintenance and IT support; and, critically, the need for an interface simple enough to be operated by any hospital staff member, including non-technical personnel such as nurses, administrative agents, and cleaning workers.

1.5 Reducing Equipment Downtime through Instantaneous Reporting

The primary operational objective of E-SIGNAL is the drastic reduction of **Equipment Downtime**—the critical period during which a medical device is non-functional and unavailable for patient care. This is not merely a technical inconvenience; it is a patient safety crisis. A non-functional ventilator in an intensive care unit, a broken fetal monitor during labor, or a failed climate control system in a neonatal ward can have immediate, life-threatening consequences.

The scale of this problem in developing countries is well documented. A comprehensive inventory study across nine tertiary hospitals in Uganda found that **on average 37% of medical devices were non-functional**, with rates reaching as high as 54% in some facilities, while 86% of surveyed equipment lacked service manuals entirely (Ssekitoleko et al., 2021). Similarly, research in Nepal demonstrated that approximately 14% of equipment was non-functional specifically in hospitals lacking trained biomedical engineers, underscoring that the problem is systemic rather than device-specific (Thapa et al., 2022). These figures reflect the **cumulative effect of inadequate maintenance ecosystems**—including poor fault-reporting mechanisms, insufficient spare parts supply chains, and the absence of trained biomedical technicians.

In traditional paper-based systems, downtime is artificially inflated by what can be termed **"administrative lag"**—the time consumed between a staff member noticing a malfunction and a technician actually beginning diagnostic work. This lag encompasses: the time to locate and fill out a paper form, the time to physically deliver it to the maintenance office, the time for the maintenance chief to read, prioritize, and assign the request, and the time for the assigned technician to receive the assignment and travel to the site. In many Algerian hospitals, this

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cumulative administrative lag can extend the total downtime from what should be a two-hour repair into a multi-day ordeal—during which the device remains unavailable, patients are transferred or undertreated, and the institution absorbs significant operational costs.

E-SIGNAL eliminates this lag through **instantaneous digital reporting**. The moment a fault is identified and the device's QR code is scanned, a digital intervention ticket is generated, classified by type and priority, and routed to the correct department—all within seconds. The technical department is notified immediately via push notification, with full contextual information (device identity, location, fault description, photographs). This compression of the reporting-to-response interval ensures that the device returns to service as quickly as the technical repair itself allows, removing all non-value-added administrative time from the process.

1.6 Optimizing Technical Efficiency: The MTTR Metric

A core innovation of E-SIGNAL is its ability to measure and improve the **Mean Time To Repair (MTTR)**—a vital Key Performance Indicator (KPI) that measures the average duration required to troubleshoot and restore a failed asset to operational status. MTTR is universally recognized in maintenance engineering as the single most important metric for evaluating corrective maintenance effectiveness. Its formula is straightforward:

$$\text{MTTR} = \text{Total Repair Time} / \text{Number of Repairs}$$

Yet in the vast majority of developing-world hospitals, this metric is **impossible to calculate accurately**. Kanamugire et al. (2023), in a comparative study examining medical device management across low- and middle-income countries, found that hospitals in these settings commonly lack trained biomedical engineers, face difficulties managing large numbers of devices, and operate without digital record-keeping systems—rendering any meaningful performance measurement structurally impossible. In such environments, there are no digital timestamps, no structured work orders, and no archived records from which to extract meaningful performance data.

E-SIGNAL changes this fundamentally. The platform automatically records **precise digital timestamps** for every stage of the maintenance process:

- **T₀**: The moment the fault is reported (QR scan)
- **T₁**: The moment the ticket is received by the department
- **T₂**: The moment a technician is assigned
- **T₃**: The moment the technician arrives on-site
- **T₄**: The moment the repair is completed
- **T₅**: The moment the reporter validates the fix

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This granular traceability provides hospital management with the data to calculate not only the overall MTTR, but also to **decompose it into sub-intervals**—distinguishing, for example, between assignment delay ($T_2 - T_1$), travel time ($T_3 - T_2$), and actual repair duration ($T_4 - T_3$). This decomposition reveals precisely where bottlenecks exist: Is the delay in assignment? In technician availability? In spare parts procurement? Such diagnostic insight is impossible with paper-based systems and represents a qualitative leap in maintenance governance.

1.7 Strategic Transformation: From Reactive to Data-Driven Maintenance

E-SIGNAL acts as the catalyst for a strategic paradigm shift in Algerian hospital management: the transition from **Reactive Maintenance**—a "break-fix" model where action is only taken after a failure has already occurred—to **Data-Driven Maintenance**, where historical patterns inform preventive interventions before breakdowns happen.

The transition from reactive to preventive maintenance is widely recognized as one of the most impactful improvements a healthcare facility can make. Research has consistently shown that preventive maintenance significantly extends the useful life of medical equipment and reduces the overall cost of ownership (Webber et al., 2020). Yet this transition requires one essential prerequisite that paper-based systems cannot provide: **structured historical data**.

By centralizing data on every fault—its type, location, frequency, associated device, and resolution time—into a searchable management dashboard, E-SIGNAL provides administrators with what can be described as "**Actionable Intelligence**." Instead of operating in a perpetual state of technical crisis, managers can:

- Identify devices with recurring failure patterns (e.g., "the ventilator in Room 12 has been reported 7 times in 3 months—it may require replacement rather than continued repair");
- Detect systemic infrastructure weaknesses (e.g., "electrical faults in the maternity wing account for 40% of all reports—the wiring may need a comprehensive upgrade");
- Evaluate technician performance objectively using MTTR data rather than subjective impressions;
- Generate evidence-based reports for budget allocation and capital expenditure planning.

This transition not only optimizes the hospital's overall maintenance budget—by preventing the premature destruction of expensive equipment through neglect—but also aligns the institution with international best practices in healthcare technology management.

1.8 Breaking Administrative Silos: The Integrative Role

A critical but often overlooked function of E-SIGNAL is its role in **breaking down the administrative silos** that traditionally separate medical staff (the equipment users) from technical

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staff (the equipment maintainers). In the conventional hospital model, these two groups operate in parallel worlds: nurses and physicians use equipment daily but have no structured channel to communicate technical problems, while maintenance technicians work in isolation, unaware of clinical priorities and the urgency hierarchy of different devices.

E-SIGNAL bridges this divide by creating a **shared digital workspace** in which both groups interact around the same data. The medical user reports the fault with clinical context ("this ventilator is connected to a patient in critical condition"), while the technician receives this context alongside technical specifications. The result is a coordinated, priority-aware maintenance process that respects clinical urgency—a feature that paper-based systems, with their inherent information asymmetry, cannot replicate.

1.9 Functional Workflow Architecture

To operationalize the concepts described above, E-SIGNAL re-engineers the traditional maintenance workflow into a **streamlined five-stage digital process**. This structured flow eliminates non-value-added activities (such as physical travel to file a report) and ensures data integrity at every touchpoint:

Stage 1 — Detection & Identification (The Scan): A medical staff member detects a technical failure and scans the equipment-specific QR code. The system automatically retrieves the device's technical profile, including its identity, location, and full maintenance history. The user then adds contextual information: priority level, fault description, and supporting photographs.

Stage 2 — Instantaneous Notification (The Alert): A digital intervention ticket is generated (e.g., INC-2025-0521) and routed via a classification algorithm to the appropriate technical department: Biomedical Engineering for medical devices, General Maintenance for infrastructure (HVAC, electrical, plumbing), or IT Support for computing equipment.

Stage 3 — Assignment & Response (The Action): The department head receives the notification with full fault details and assigns a technician based on the current shift schedule. This step triggers the MTTR timer. The assigned technician receives: the fault description with photographs, the exact device location, and the device's prior repair history.

Stage 4 — Resolution & Documentation (The Repair): The technician updates status in real time (Received → En route → On-site → Repairing). Upon completion, the system prompts documentation: the nature of the intervention (internal or external), spare parts used and their cost, and before/after photographs. The device's digital lifecycle record is updated accordingly.

Stage 5 — Validation & Analytics (The Feedback): The original reporter validates the repair and rates the service quality. All data is archived into the Management Dashboard, where KPIs are

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updated, MTTR is calculated, recurring fault patterns are logged, and exportable monthly reports become available for administrative decision-making.

2- Legal Framework and Regulatory Integration

The strategic viability of E-SIGNAL is anchored in its strict alignment with the Algerian legislative ecosystem. The project is not merely a technical innovation but a **regulatory response** to national mandates for health modernization, digital sovereignty, and the optimization of public resources.

2.1 Alignment with Health Law 18-11: Ensuring Continuity of Care

The cornerstone of our legal integration is **Law No. 18-11 of July 2, 2018, relating to health** (Journal Officiel de la République Algérienne n° 46, 29 July 2018). This comprehensive law of 450 articles establishes the fundamental principles of the national health policy.

Article 3 of this law defines the core objectives of the national health system, explicitly including *"la garantie de la continuité du service public de santé"* (the guarantee of continuity of the public health service) and *"la sécurité sanitaire"* (health security). A non-functional medical device directly compromises this continuity: when a fetal monitor fails in a maternity ward, the chain of care is broken. E-SIGNAL, by drastically reducing equipment downtime, acts as a **digital guarantor** of the continuity mandated by Article 3.

Article 21 further reinforces this foundation by establishing the patient's fundamental right: *"Toute personne a droit à la protection, à la prévention, aux soins et à l'accompagnement qu'exige son état de santé, en tous lieux et à toutes les étapes de sa vie."* (Every person has the right to the protection, prevention, care, and support that their health condition requires, in all places and at all stages of life.) A hospital that cannot guarantee functional equipment is, by definition, failing to fulfill this statutory obligation. E-SIGNAL ensures that healthcare establishments remain compliant by providing the mechanism through which equipment availability is continuously monitored and rapidly restored.

2.2 Integration into the National Digital Transformation Strategy

E-SIGNAL directly contributes to Algeria's national vision for **digital transformation** in public services. The state has committed to the **"Dématérialisation"** (dematerialization / zero-paper) of administrative procedures within public institutions—replacing paper-based workflows with digital, traceable, and auditable systems.

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Our project operationalizes this vision within the hospital maintenance domain by replacing obsolete manual maintenance registers—prone to loss, illegibility, and manipulation—with a **digital, non-alterable database**. Every intervention ticket, every status update, every technician report is timestamped and permanently archived. This shift ensures "**Digital Governance**" within the hospital: a transparent and auditable trail of all technical interventions that can be reviewed by institutional auditors, health authorities, or accreditation bodies at any time.

This is not a marginal improvement; it represents a fundamental transformation in how maintenance data is created, stored, and used—moving from fragmented, perishable paper records to centralized, permanent digital intelligence.

2.3 Rationalization of Public Expenditure and Asset Preservation

From a fiscal perspective, E-SIGNAL serves the state's mandate for "**Economic Rationalization**" (ترشيد النفقات العمومية)—the responsible stewardship of public resources. The Algerian Constitution and relevant financial legislation mandate the preservation of public assets and the efficient allocation of public funds.

Medical equipment represents one of the most significant capital investments for any healthcare institution. A single MRI machine can cost several hundred million Algerian dinars; a fully equipped intensive care unit represents billions in public investment. When these devices fail prematurely due to neglected maintenance—because a fault was reported late, lost in a paper trail, or never escalated to the appropriate technician—the state is forced into **emergency procurement** at substantially higher cost, often bypassing normal budgetary planning cycles.

E-SIGNAL serves as a tool for **Asset Preservation** by:

- Ensuring that every fault is reported immediately and routed correctly (no lost requests);
- Enabling preventive maintenance based on historical failure data (extending equipment lifespan);
- Providing management with cost data on spare parts and repairs (informing replacement decisions);
- Generating reports that justify maintenance budgets with empirical evidence rather than estimates.

In this way, the platform transforms maintenance from a cost center into a **strategic savings mechanism**—protecting public investment and reducing the total cost of ownership of the hospital's equipment portfolio.

2.4 The Institutional Framework of Ministerial Decree 1275

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Finally, E-SIGNAL is legally framed within **Ministerial Decree No. 1275 (2022)**, which establishes the "University-Startup" mechanism (*"Un diplôme, une startup / micro entreprise, un brevet d'invention"*). This decree provides the legal framework for university graduation projects to be developed not merely as academic exercises but as **viable entrepreneurial ventures** with real socioeconomic impact.

Under this decree, E-SIGNAL has the institutional pathway to transition from a thesis project into a registered **"Innovative Project" (Label Projet Innovant)**, with access to incubator support, mentorship, and potential funding. It bridges the gap between scientific research and economic productivity, ensuring that our solution has the necessary institutional legitimacy to be piloted, validated, and ultimately scaled across the national health network.

2.5 Compliance with Algerian Data Protection Law (Law 18-07) and Patient Privacy

The digitalization of hospital workflows introduces significant regulatory responsibilities. Under the Algerian Law No. 18-07 (relating to the protection of natural persons in the processing of personal data), medical and patient-related information is legally classified as highly sensitive data. E-SIGNAL is rigorously designed to not only optimize maintenance processes but to ensure absolute compliance with this legal framework. While utilizing localized Algerian servers guarantees national data sovereignty, the platform must also proactively safeguard individual patient confidentiality during daily reporting operations.

The Operational Vulnerability in Fault Reporting A critical vulnerability in modern digital maintenance occurs during the photographic documentation of hardware faults. When a caregiver or technician captures an image of a malfunctioning device—such as a ventilator in an Intensive Care Unit (ICU) or a monitoring screen in an emergency room—there is a high probability of inadvertently capturing a patient's face, clinical monitors, or bed identification tags in the background.

Currently, when medical staff rely on informal communication tools like WhatsApp to report these issues, they unknowingly commit severe breaches of medical secrecy. Uncensored images containing patients are saved onto personal smartphones and transmitted to foreign servers, exposing the hospital administration to severe legal liability.

The Technological Failsafe: Automated Visual Anonymization To systematically neutralize this legal and ethical risk, E-SIGNAL introduces a core proprietary security feature: **Automated Visual Anonymization**. Rather than relying on the user to manually crop or hide patient details, the platform integrates an AI-powered filter that operates directly on the user's device (Edge Processing) before any data leaves the smartphone.

The anonymization workflow is executed in three instantaneous, frictionless steps:

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- **Capture & Local Processing:** The user captures a photo of the malfunctioning equipment using the in-app camera.
- **Detection & Blurring:** The integrated algorithm instantly scans the raw image to identify human faces and recognizable text (such as patient names or medical charts). It immediately applies a permanent Gaussian blur to these sensitive areas.
- **Secure Transmission:** Only the "sanitized" image—where the faulty machine is clearly visible but the background and patient identities are fully obscured—is transmitted via end-to-end encryption to the secure local servers.

Strategic Value for Hospital Governance By embedding this automated compliance layer, E-SIGNAL transforms data protection from a manual burden into a guaranteed systemic feature. It provides Hospital Directors and the Regional Health Directorates (DSP) with a secure, verifiable database. The administration can confidently prove that 100% of the maintenance records are free from compromised patient data. This architectural failsafe ensures that rapid technical intervention never comes at the cost of patient privacy, thereby aligning the hospital with the highest standards of healthcare accreditation and legal compliance.

3- Visual Identity and Brand Architecture

A coherent visual identity is not decorative—it is strategic. In healthcare digital products, the brand system must simultaneously communicate institutional credibility, operational urgency, and user accessibility. The E-SIGNAL visual identity was designed as an integrated brand architecture where every element—name, mark, tagline, palette, and typography—reinforces a single message: **rapid, reliable, trustworthy maintenance communication.**

3.1 The Name: E-SIGNAL

The brand name is a two-part semantic construction:

"E-" functions as a digital prefix, immediately situating the platform within the recognized lexicon of digital transformation: e-health, e-government, e-learning. For a Ministerial Decree 1275 project, this prefix signals technological modernity and aligns the product with Algeria's national digitization agenda. It is concise, universal, and requires no translation across Arabic, French, or English contexts.

"SIGNAL" operates on two levels. Denotatively, a signal is the transmission of critical information from a source to a receiver—which is precisely what the platform does: it transmits a fault alert from medical staff to the maintenance team. Connotatively, a signal implies urgency, a call for immediate attention, a warning that cannot be ignored. In the healthcare context, this double meaning is deliberate: **E-SIGNAL** gives a voice to equipment that would otherwise fail silently, unnoticed until a patient is affected.

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The hyphenated form "**E-Signal**" creates a rhythmic, two-beat name that is easy to pronounce in Arabic (إي-سينيال), French, and English—a critical consideration for a bilingual platform deployed in an Algerian institutional environment.

3.2 The Logo: Anatomy and Symbolism

Image (01) : Official Logo of the E-SIGNAL Project



Source: Created by the author for the E-SIGNAL project (2026).

The E-SIGNAL logomark is a **custom monogram** combining two visual elements into a single, unified glyph:

The Stylized "E": The letter "E" is rendered with sharp, angular strokes that break away from conventional rounded letterforms. The open structure of the "E" suggests accessibility and openness—the platform is designed for everyone in the hospital, not just technical staff.

The Integrated Lightning Bolt (⚡): A diagonal lightning bolt passes through and extends from the upper strokes of the "E," creating a dynamic visual tension. This element carries three layers of brand meaning:

- **Speed:** Lightning is the universal symbol of instantaneous action—the core promise of the platform (fault reporting in under 30 seconds);
- **Electrical/Technical Domain:** The bolt is a direct visual reference to engineering, maintenance, and the technical infrastructure that E-SIGNAL manages;
- **Energy and Proactivity:** Unlike passive symbols (circles, shields), the bolt conveys forward motion and initiative—the platform does not wait, it acts.

Logomark Construction: The fusion of the "E" and the bolt into a single mark is a deliberate design decision. Rather than placing a generic icon beside text, E-SIGNAL's mark is **self-contained and indivisible**—it functions at every scale, from a 48×48px mobile app icon to a

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printed letterhead, without losing legibility or symbolic clarity. The mark sits above the logotype ("E-Signal") and tagline in a **vertically stacked lockup**, establishing a clear visual hierarchy: symbol → name → promise.

Rendering: The logo is executed in a single color—**dark teal-blue (#1B3A4B)**—against a white or light background. This monochromatic approach ensures maximum versatility across print, screen, and low-resolution contexts (QR code stickers on devices, ID badges, official documents).

3.3 The Tagline: "Act Faster, Care Better"

The tagline "**Act faster, Care better**" is structured as a **causal proposition in four words**:

- "**Act faster**" = the operational input (what the platform enables);
- "**Care better**" = the clinical outcome (what the hospital achieves).

The grammatical parallelism (verb + comparative, verb + comparative) creates a memorable, rhythmic phrase that works equally well in English, French ("Agir plus vite, Soigner mieux"), and transliterated Arabic. The tagline does not describe a feature—it describes a **result**. This is a critical distinction in healthcare branding: stakeholders (hospital directors, ministry officials, investors) are not interested in QR codes or push notifications; they are interested in patient care outcomes and operational efficiency.

The tagline is positioned beneath the logotype in a lighter weight and smaller size, functioning as a brand promise rather than a headline—always present, never competing with the logomark for visual dominance.

3.4 Color Palette

The E-SIGNAL color system is built on a **restrained, high-contrast palette** that prioritizes legibility, clinical appropriateness, and functional coding:

Primary — Dark Teal-Blue (#1B3A4B): The dominant brand color, used for the logomark, primary UI elements, and headers. This deep blue-green tone sits at the intersection of trust (blue) and stability (dark value). In color psychology applied to healthcare interfaces, dark blue tones are consistently associated with authority, competence, and reliability. Unlike bright blues (which can feel consumer-oriented) or navy (which can feel corporate-cold), this teal-blue conveys **professional warmth**.

Secondary — White (#FFFFFF): The primary background color, providing maximum contrast for readability and evoking the clinical cleanliness of the hospital environment. White space is used generously throughout the interface to reduce cognitive load—critical for users operating under time pressure and stress.

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Functional Accent Colors — Priority Triage System: The UI employs a color-coded priority scale that functions as an instant visual triage, mirroring the clinical triage logic familiar to all hospital staff:

Table (01) : Priority Color Coding System for E-SIGNAL Maintenance Requests

Priority	Color	Hex	Meaning
Emergency	Red	#DC2626	Life-threatening — immediate action
Urgent	Orange	#EA580C	Serious — respond within hours
Important	Amber	#F59E0B	Significant — respond within 24h
Normal	Green	#16A34A	Routine — scheduled response

Source: Created by the author for the E-SIGNAL project (2026).

This four-tier color system enables any user—regardless of language or literacy level—to assess the severity of a request at a single glance.

3.5 Typography

The typographic system is designed for **maximum legibility under adverse reading conditions** (small screens, poor lighting, hurried scanning):

Sans-Serif Primary Typeface: The interface uses a clean, geometric sans-serif family with even stroke widths and open apertures. Sans-serif fonts are the standard for digital healthcare interfaces because they render crisply at small sizes on both high- and low-resolution screens.

Bilingual Architecture (Arabic RTL + French & English LTR): The typography system supports seamless switching between right-to-left Arabic and left-to-right French and English layouts. This is not merely a translation feature—it involves mirroring the entire interface layout (navigation, alignment, icon positioning) to feel native in both languages. Arabic typography uses

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a matched sans-serif Arabic typeface with equivalent visual weight to maintain design consistency across languages.

Type Hierarchy: A disciplined type scale ensures that information hierarchy is communicated through size and weight: ticket numbers in bold monospace for instant identification, status labels in medium weight for quick scanning, and body descriptions in regular weight for detailed reading. The most critical information (ticket ID, priority level, device location) is always the first element the eye captures.

4- Core Values

The E-SIGNAL brand is anchored by four foundational values. These are not aspirational slogans—they are **design constraints** that govern every product decision:

Speed: Every interaction is optimized for minimum time. The 30-second reporting target is a measurable design benchmark: if a new feature increases reporting time, it is redesigned or removed. Speed is not about technology—it is about respecting the clinical staff's most scarce resource: time away from patient care.

Transparency: Every action in the system is visible, timestamped, and attributable. The reporter sees exactly where their request stands. The technician's response time is recorded. The administrator can audit any ticket from creation to closure. There are no black boxes, no lost requests, no unanswered questions. Transparency builds trust—and trust drives adoption.

Simplicity : The interface is designed for the **least technically experienced user** in the hospital. The design test is explicit: if a cleaning worker encountering the app for the first time cannot report a broken light fixture without instructions, the design has failed. Simplicity is not the absence of functionality—it is the discipline of hiding complexity behind intuitive interactions.

Continuity: The platform exists to guarantee one thing: uninterrupted healthcare delivery. Every technical feature—offline mode, automatic escalation when a ticket is unacknowledged, shift-based technician routing—serves this single objective. E-SIGNAL does not exist for its own sake; it exists so that equipment works, care continues, and patients are safe.

5-Project Goals and Objectives

The primary mission of **E-Signal** is to modernize the hospital maintenance ecosystem in Algeria through digitalization, ensuring that critical medical infrastructure is always operational to save lives.

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- **Bridging the Communication Gap:** To establish an instant and seamless communication channel between medical staff (caregivers) and technical teams, eliminating the delays inherent in traditional reporting methods.
- **Minimizing Equipment Downtime:** To drastically reduce the Mean Time to Repair (MTTR) by providing technicians with immediate access to fault data and equipment location through QR code technology.
- **Ensuring Data Sovereignty:** To promote the national strategy for health digitalization by hosting sensitive hospital data on secure, localized Algerian servers, ensuring full compliance with national security regulations.
- **Optimizing Resource Management:** To provide hospital administrators with data-driven insights (KPIs) to optimize maintenance budgets, manage spare parts inventories, and extend the lifespan of medical devices.
- **Enhancing Patient Safety:** To ensure the continuous availability of life-saving equipment (e.g., ventilators, dialysis machines), thereby directly improving the quality of patient care and hospital reliability.

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Table (02): Definition of E-Signal Objectives according to the SMART Method

Criterion	SMART	Objective
Specific	S	Launch the E-Signal mobile and web platform for instant hospital maintenance management, targeting initial deployment at EHS Mère et Enfant Tlemcen .
Measurable	M	Reach <u>300 healthcare facilities</u> (public and private) within the first 12 months and monitor a 40% reduction in average equipment downtime.
Attainable	A	Leveraging a specialized B2G management team with institutional expertise and technical leadership from the AI House (ESMT) to ensure seamless integration into public procurement and hospital systems.
Realistic	R	Addressing the critical and urgent need for health sector digitalization in Algeria through an intuitive interface and a high-fidelity prototype already validated by professionals.
Time-bound	T	Complete the pilot phase at EHS Tlemcen by August 2026 and achieve regional expansion across TLEMCEN by August 2027 .

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Source: Created by the author for the E-SIGNAL project (2026).

6-The Originality of the Idea

A Disruptive Digital Solution for Optimized Maintenance: E-Signal fundamentally reinvents the reporting and tracking process of hospital equipment breakdowns through a simple yet highly effective technology: the QR Code. Unlike traditional, cumbersome paper-based procedures or untracked phone calls, E-Signal provides an instantaneous digital bridge. By simply scanning the QR code affixed to a medical device, the healthcare professional generates an immediate, geo-located alert detailing the exact fault. This algorithmic routing ensures that the right technical team is notified in real-time, drastically reducing the diagnostic phase and ensuring a highly optimized, trace-driven maintenance lifecycle.

Empowering Healthcare Professionals and Transforming Workflows: One of the major operational bottlenecks in Algerian hospitals is the administrative burden placed on medical staff during equipment failures. The originality of E-Signal lies in its user-centric approach that liberates caregivers from logistical constraints. By minimizing the time spent dealing with broken machines (such as ventilators or incubators), the platform allows doctors and nurses to refocus entirely on patient care. Concurrently, it professionalizes the technical staff's workflow by providing them with a prioritized, clear, and manageable digital ticketing system, replacing the chaos of verbal requests.

Breaking Institutional Silos Through Interdepartmental Synergy: Traditionally, hospital departments—Medical, Technical, and Administrative—operate in isolated silos, leading to communication gaps and inefficiencies. E-Signal acts as a centralized collaborative ecosystem. It is not merely an alert system, but a unified management platform. While caregivers report issues and technicians resolve them, hospital managers access a strategic dashboard featuring real-time Key Performance Indicators (KPIs). This transparency fosters unprecedented synergy, allowing administration to objectively evaluate technician reactivity (MTTR - Mean Time to Repair), anticipate recurring breakdowns, and optimize the overarching maintenance budget.

Adaptation to the Algerian Healthcare Ecosystem and Data Sovereignty: Unlike generic, imported CMMS (Computerized Maintenance Management System) software, E-Signal is specifically tailored to the structural, bureaucratic, and economic realities of Algerian public and private hospitals (B2G and B2B contexts). A core pillar of its originality is the strict adherence to **Data Sovereignty**. E-Signal guarantees that all sensitive hospital data and institutional statistics are securely hosted on localized Algerian servers. Furthermore, the application's workflow is designed to align seamlessly with the administrative procedures of the Algerian healthcare sector, ensuring rapid institutional adoption and full compliance with national digitalization directives.

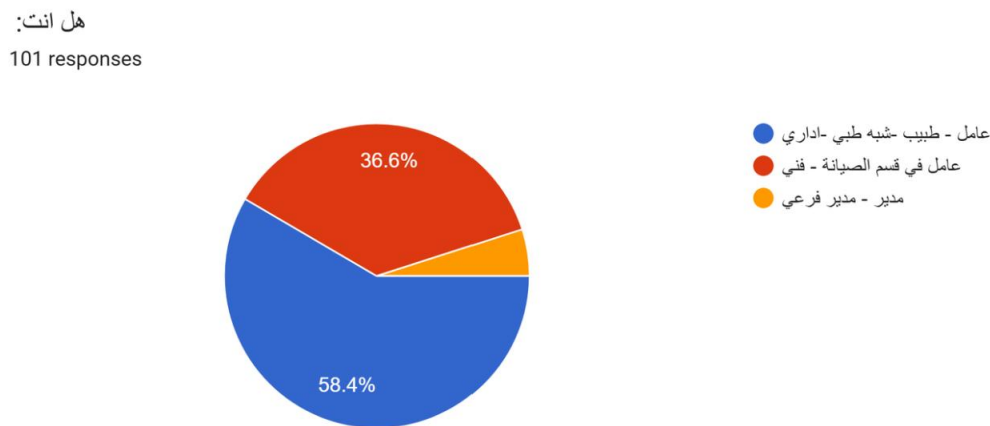
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7-Field Study and Needs Assessment: Analysis of Public Health Institutions

To precisely identify the bottlenecks in hospital maintenance management, a field survey was conducted across three public healthcare institutions. Data was collected via a digital questionnaire from 101 professionals directly involved in the daily operations of these hospitals. This empirical approach guarantees the reliability of the data and grounds the **E-Signal** project in the operational reality of the Algerian healthcare sector (B2G).

7.1 Demographic Profile of Respondents: A Multi-Stakeholder Approach

Figure (01) : Distribution of Survey Respondents by Professional Role



Source: Created by the author based on field survey results (2026).

Data Breakdown:

- **58.4% Medical, Paramedical, and Administrative Staff:** This majority represents the front-line healthcare workers (doctors, nurses, ward clerks). They are the primary users of medical equipment and the first to confront breakdowns.
- **36.6% Maintenance and Technical Staff:** This significant segment represents the technicians responsible for repairing the equipment. Their input is crucial for understanding the challenges related to intervention delays and lack of clear fault descriptions.
- **5.0% Managers and Sub-managers:** This group represents the hospital administration, whose primary concern is resource optimization, equipment availability, and performance monitoring.

Strategic Analysis and Link to E-Signal: The distribution of this sample is highly representative of the hospital ecosystem and perfectly validates the architectural foundation of the **E-Signal** platform. The survey captures the "pain points" from all sides of the maintenance equation: those

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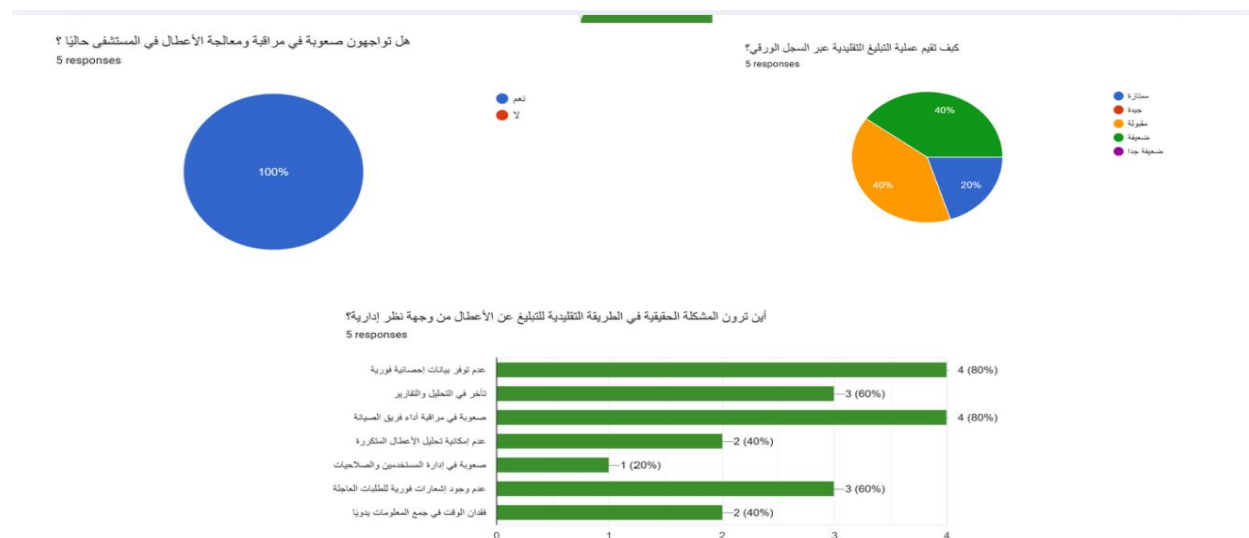
who suffer from the breakdown (Medical Staff), those who must fix it (Technicians), and those who oversee the budget and performance (Managers).

By identifying that these three distinct groups are interlinked but currently lack an efficient communication channel, this demographic analysis directly justifies the creation of E-Signal's **three-tiered multi-role platform** (Caregiver Interface, Technician Interface, and Manager Dashboard). It proves that the solution is not just a tool for technicians, but a collaborative ecosystem designed for the entire hospital staff.

7.2 The Administrative Perspective: A Critical Need for Traceability and Data-Driven Governance

Hospital administration plays a crucial role in resource optimization and ensuring the continuous availability of medical equipment. However, the survey reveals severe systemic flaws in the current management paradigm. The feedback from managers and sub-managers highlights a deep frustration with traditional methods.

Figure (02) : Evaluation of Traditional Maintenance Reporting Methods by Hospital Administration



Source: Created by the author based on field survey results (2026).

Analysis of the Administrative Bottlenecks:

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- **Unanimous Consensus on Management Difficulties (The 100% Metric):** A striking **100%** of the surveyed administrators explicitly stated that they currently face significant difficulties in monitoring and processing equipment breakdowns. This absolute consensus is a powerful indicator that the current operational system is not merely inefficient, but fundamentally obsolete.
- **The Obsolescence of Paper-Based Tracking:** When asked to evaluate the traditional paper-register reporting method, the majority of the administration rated it negatively. **40%** consider it "weak," and another **40%** find it barely "acceptable." This confirms that analog tracking cannot keep pace with the urgent demands of a modern healthcare facility.
- **Identifying the Core Pain Points:** To dig deeper into the root causes of this systemic failure, administrators pinpointed their exact frustrations with the traditional method:
 - **Lack of Instant Statistical Data (80%):** Managers are operating blindly. Without real-time data, it is impossible to make informed financial or operational decisions regarding equipment replacement or budget allocation.
 - **Inability to Monitor Technician Performance (80%):** There is a total lack of visibility regarding the efficiency, response time, and workload of the maintenance teams.
 - **Delayed Notifications and Reporting (60%):** Urgent repair requests are often lost in bureaucratic delays, and analytical reports take too long to generate manually, costing valuable time (noted by 40% of respondents).

Strategic Alignment with E-Signal (The Solution): These profound administrative frustrations perfectly validate the necessity of E-Signal's third tier: **The Manager Dashboard**.

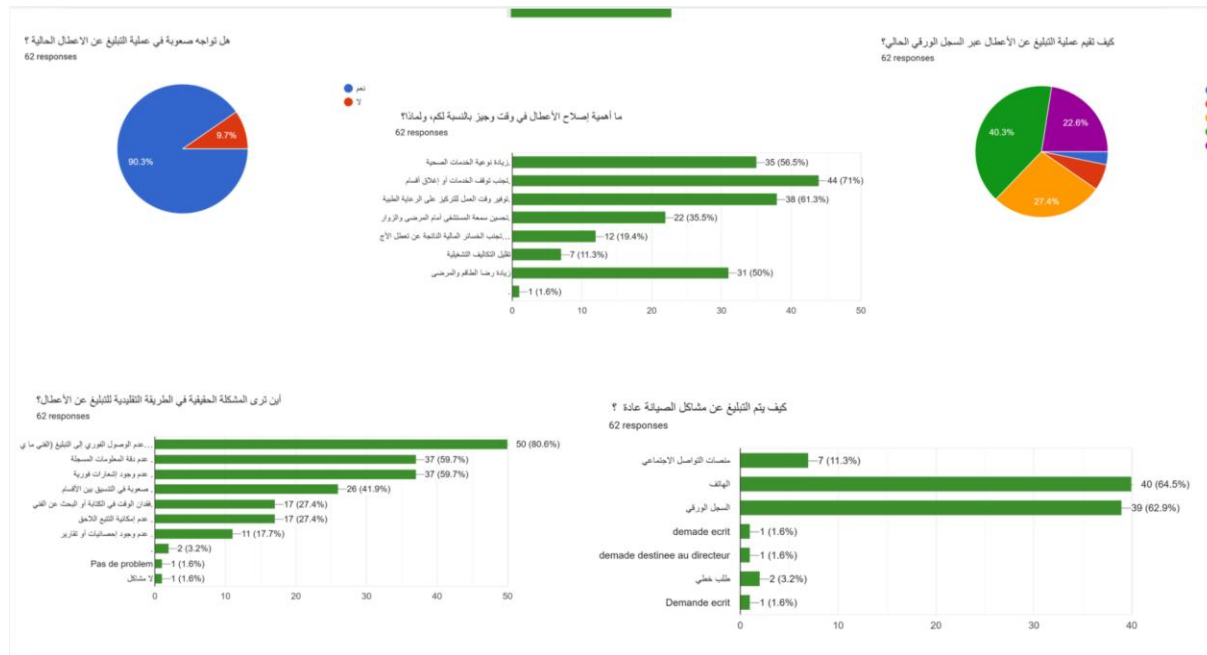
By transitioning from an untraceable paper-based system to E-Signal, hospital directors are empowered with a centralized, real-time control panel. The platform directly addresses the 80% pain points by automatically generating Key Performance Indicators (KPIs), tracking the Mean Time to Repair (MTTR), and evaluating technician performance objectively. Ultimately, E-Signal shifts hospital administration from a reactive, paper-heavy approach to a transparent, "**Data-Driven**" governance model.

7.3 The Medical Staff Perspective: The Urgency of Reactivity and Patient Care Focus

The medical and paramedical staff represent the front line of hospital operations. They are the primary users of vital medical equipment, and consequently, the first to suffer the consequences of breakdowns. Their survey responses highlight a critical friction point between clinical duties and administrative hurdles.

Figure (03) : Evaluation of the Breakdown Reporting Process by Medical Staff

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Source: Created by the author based on field survey results (2026).

Analysis of the Clinical Bottlenecks:

- **An Overwhelming Operational Friction (The 90.3% Metric):** A massive 90.3% of the surveyed medical personnel reported facing major difficulties with the current breakdown reporting process. Furthermore, when evaluating the traditional paper register, over 62.9% rated it as either "poor" or "very poor." This clearly demonstrates that the current tools are entirely unsuited to the fast-paced nature of medical emergencies.
- **The Core Problem: Lack of Instant Communication:** When asked to identify the real flaw in the traditional method, a striking 80.6% pointed to the "lack of instant access to the technical team." Currently, staff rely heavily on phone calls (64.5%) and manual paper logs (62.9%). This multi-step, analog process forces doctors and nurses to abandon their patients to hunt down a technician or fill out paperwork.
- **The Clinical Impact of Downtime:** The survey brilliantly captures *why* rapid repair is crucial for the medical staff. 71% emphasized the absolute necessity to "avoid stopping services or closing departments," while 61.3% stated that fast repairs "save work time, allowing them to focus on medical care." This proves that equipment downtime is not just a technical issue; it is a direct threat to healthcare continuity.

Strategic Alignment with E-Signal (The Solution):

The frustrations expressed by the medical staff perfectly validate the core innovation of **E-Signal: The Caregiver Interface (Espace Soignant)** driven by QR Code technology. By completely

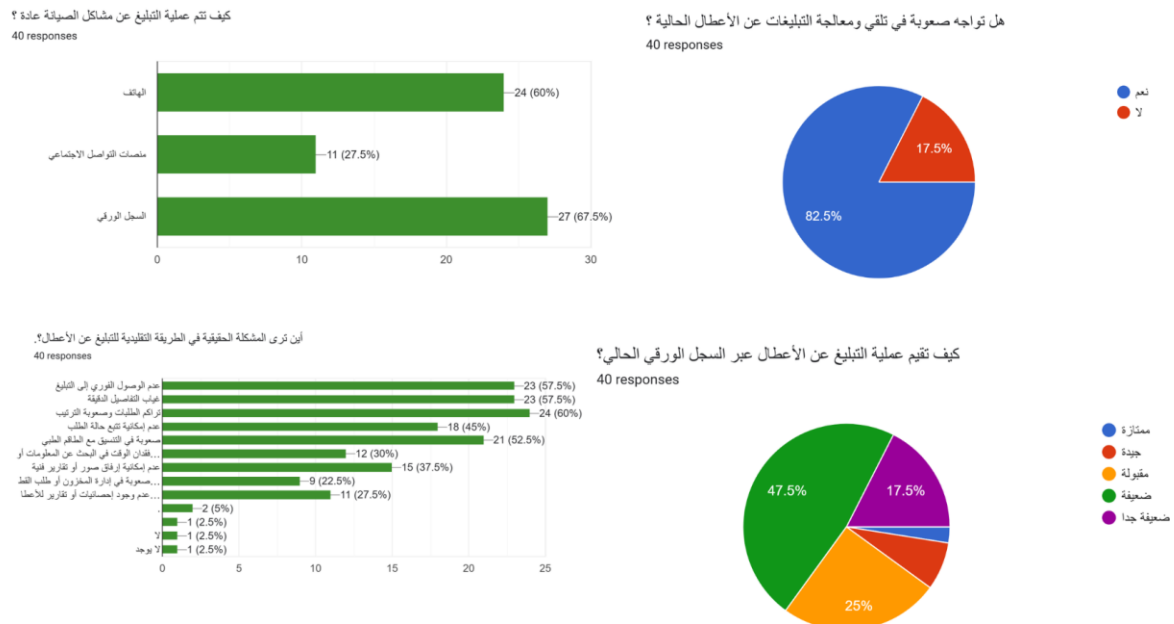
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eliminating the reliance on phone calls and paper registers, E-Signal resolves the primary bottleneck (the 80.6% complaint regarding instant access). A simple, one-second scan of a QR code generates an immediate, geo-located alert. This digital transformation liberates the medical staff from frustrating administrative tasks, ensuring that 100% of their time and focus is redirected exactly where it belongs: patient care.

7.4 The Technical Team Perspective: The Need for Precision, Prioritization, and Digital Workflows

The maintenance and technical staff form the operational engine of any healthcare institution. Their ability to react swiftly and accurately dictates the uptime of critical medical infrastructure. However, the survey results from the technical teams expose a chaotic and highly inefficient working environment, reinforcing the absolute necessity for a digital overhaul.

Figure (04) : Evaluation of Maintenance Request Reception and Management by Technical Staff



Source: Created by the author based on field survey results (2026).

Analysis of the Technical Bottlenecks:

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- **A System Overwhelmed by Inefficiency (The 82.5% Metric):** An alarming **82.5%** of surveyed technicians confirm they face significant difficulties in receiving and processing breakdown reports. This overwhelming majority proves that the current operational workflow is fundamentally broken and acts as a barrier to efficient maintenance.
- **The "Triple Threat" of Traditional Maintenance:** When dissecting the root causes of these difficulties, the technicians highlighted three major operational paralyzers:
 1. **Chaos and Lack of Prioritization (60%):** The highest frustration cited is the "accumulation of requests and difficulty in prioritization." Relying on phone calls (60%) and paper registers (67.5%) creates a disorganized queue where a broken life-saving ventilator might be treated with the same urgency as a broken office chair.
 2. **The Information Deficit (57.5%):** Technicians suffer from a severe "lack of precise details." A medical staff member might simply write "machine broken" in a register, forcing the technician to waste valuable time diagnosing a problem that could have been visually documented.
 3. **Communication Breakdown (57.5% & 52.5%):** The lack of instant access to the reporter (57.5%) and the difficulty in coordinating with the medical departments (52.5%) create a frustrating disconnect between the two most important actors in the hospital.
- **Rejection of Analog Tools:** It is no surprise that a combined **65%** of technicians rate the current paper register system as either "poor" (47.5%) or "very poor" (17.5%).

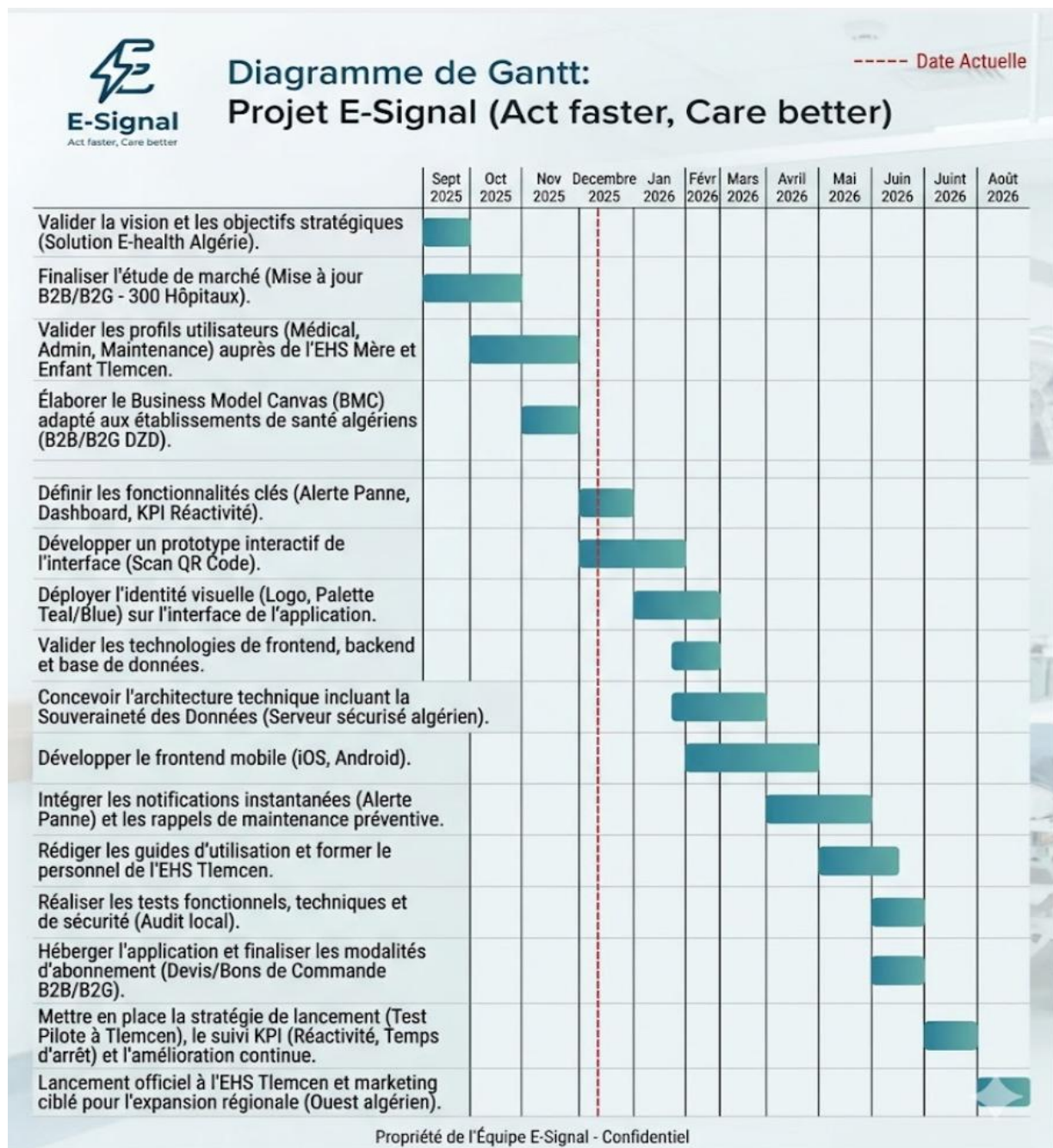
Strategic Alignment with E-Signal (The Ultimate Solution): This data represents the ultimate validation for the core architecture of **E-Signal: The Technician Interface (Espace Technicien)**. E-Signal transforms hospital maintenance from a reactive, chaotic chore into a proactive, organized science.

- **Precision via QR Code:** When a doctor scans a QR code, the technician instantly receives a digital ticket containing the exact equipment ID, precise geolocation (e.g., Room 305, Intensive Care), and attached photos, completely solving the 57.5% "information deficit."
- **Smart Prioritization:** The digital dashboard automatically categorizes and prioritizes alerts based on urgency and department, eliminating the 60% complaint regarding request accumulation.
- **Seamless Coordination:** E-Signal bridges the 52.5% communication gap by allowing technicians to update the repair status (Pending, In Progress, Resolved) in real-time, instantly notifying the medical staff without the need for disruptive phone calls.

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8-Project Implementation Schedule

Figure (05) : Gantt Chart for the E-SIGNAL Project Implementation Schedule



Source: Created by the author for the E-SIGNAL project (2026).

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Explanation of the E-Signal Gantt Chart: The Gantt chart visually represents the implementation schedule of the E-Signal project over a 12-month period, from September 2025 to August 2026. Each bar indicates the duration of a specific task, illustrating the logical sequencing, dependencies, and strategic overlaps required to transition from the initial conceptualization to the official regional launch.

Analysis of the Project Stages:

- **Months 1 to 2 (September – October 2025): Strategic Framing and Market Study** The project initiates with the validation of the vision and strategic objectives, positioning E-Signal clearly as an E-health solution tailored for Algeria. Concurrently, a comprehensive market study is finalized. This study specifically targets the B2B and B2G (Business-to-Government) sectors, encompassing a sample of 300 hospitals. This phase is critical for grounding the project in reality, ensuring that the proposed solution aligns with the structural needs and bureaucratic realities of the Algerian public healthcare system.
- **Months 2 to 4 (October – December 2025): User Validation and Business Modeling** During this phase, the project moves from macro-level analysis to micro-level user validation. The team validates the specific user profiles (Medical Staff, Administration, and Maintenance Technicians) through direct engagement with the *Établissement Hospitalier Spécialisé (EHS) Mère et Enfant* in Tlemcen. This hands-on approach ensures the application's roles accurately reflect real hospital hierarchies. Subsequently, the Business Model Canvas (BMC) is elaborated and tailored specifically to Algerian healthcare institutions, defining the B2B/B2G revenue streams in local currency (DZD).
- **Months 4 to 6 (December 2025 – February 2026): Prototyping and UI/UX Design** This period marks the beginning of the technical materialization of E-Signal. The core functionalities are clearly defined, notably the breakdown alerts, the management dashboard, and the reactivity KPIs. Immediately after, an interactive prototype of the interface is developed, centering on the flagship "QR Code Scan" feature. Parallel to the prototyping, the visual identity (logo and the Teal/Blue color palette) is deployed to ensure a professional, medical-grade User Interface (UI) that inspires trust among healthcare professionals.
- **Months 6 to 8 (February – April 2026): Technical Architecture and Core Development** Once the interface is validated, the technical foundation is solidified. The team validates the frontend, backend, and database technologies. A critical milestone in this phase is the design of the technical architecture with a strict emphasis on "Data Sovereignty"—ensuring that all sensitive hospital data is hosted on secure, localized Algerian servers. Following this architectural validation, the intensive development of the mobile frontend for both iOS and Android platforms commences.

◇ Axis one : Project Presentation

- **Months 8 to 10 (April – June 2026): Feature Integration and Staff Training** With the frontend developed, complex backend features are integrated, specifically the instant push notifications for breakdown alerts and automated reminders for preventive maintenance. Recognizing that technological adoption relies heavily on human factors, this phase strategically includes the drafting of user manuals and the direct training of the personnel at EHS Tlemcen. Preparing the staff beforehand guarantees a smoother transition during the upcoming testing phase.
- **Month 10 (June 2026): Auditing, Security, and B2G Compliance** Before any live deployment, the application undergoes rigorous functional, technical, and security testing (local audits) to prevent any critical failures in a high-stakes hospital environment. Simultaneously, the application is officially hosted, and the administrative modalities for subscriptions are finalized. This includes preparing the official quotes (Devis) and purchase orders (Bons de Commande) compliant with B2B and B2G public procurement regulations.
- **Months 11 to 12 (July – August 2026): Pilot Launch and Regional Expansion** The culmination of the project begins with a Pilot Test strategy implemented directly at EHS Tlemcen. This pilot allows the team to track real-world KPIs (such as technician reactivity and equipment downtime reduction) and apply continuous improvements based on live feedback. Finally, in August 2026, E-Signal is officially launched at EHS Tlemcen, accompanied by a targeted marketing campaign designed to scale the solution regionally across other healthcare facilities in Western Algeria.

9-Project Team

A Fundamental Pillar for Project Success The success of any technological innovation project, particularly in the sensitive healthcare sector, relies heavily on the quality and complementarity of its team. E-SIGNAL is no exception. Composed of professionals and experts with highly diversified profiles, our team embodies the core values of the project: innovation, performance, and excellence. Each member brings specific expertise that synergistically contributes to the development, commercialization, and optimization of our hospital CMMS (Computerized Maintenance Management System) platform.

A Multidisciplinary Team at the Service of E-SIGNAL: The E-SIGNAL team consists of four key experts from complementary fields, allowing for optimal management of the project across all strategic and operational aspects:

- Strategic management of healthcare services and leadership.
- Marketing strategy, communication, and commercial development.
- Technical development, Artificial Intelligence, and information systems security.

◇ Axis one : Project Presentation

- Institutional negotiation (B2G), sales, and public procurement management.

This diversity of competencies enables E-SIGNALEMENT to effectively meet the complex requirements of healthcare establishments in Algeria and ensure the deployment of a robust and secure solution.

Detailed Presentation of Team Members:

1. Benhamou Mohamed – Founder & Chief Executive Officer (CEO)

- **Profile:** Mohamed is currently completing his Master 2 in Health Services Management at the Higher School of Management (ESM) of Tlemcen, standing out as the first-ranked student in his cohort.
- **Key Competencies:** * Project management and strategic leadership;
 - Deep understanding of the hospital ecosystem;
 - Development of institutional partnerships.
- **Role within E-SIGNAL:** As the CEO, Mohamed defines the global vision and strategic roadmap of the project. He oversees all activities related to the application's deployment and makes high-level strategic decisions. His role is also central in creating and managing high-value collaborations with healthcare partners, particularly clinics and hospitals, ensuring the solution perfectly aligns with market needs.

2. Benabdallah Salah Eddine – Co-founder & Chief Marketing Officer (CMO)

- **Profile:** Salah Eddine is a Master 2 student specializing in Health Services Management at the Higher School of Management (ESM) of Tlemcen.
- **Key Competencies:** * B2B/B2G marketing strategy development;
 - Digital communication and branding;
 - Sales performance analysis (KPIs).
- **Role within E-SIGNAL:** As the CMO, Salah Eddine drives the platform's commercial growth. He is responsible for developing and executing the application's marketing strategy. He manages communication, promotion, and acquisition campaigns to build and retain the user base. Furthermore, he rigorously monitors commercial performance to adjust the brand's positioning and maximize market penetration.

3. Dr. SAIDI Meryem – Co-founder & Chief Technology Officer (CTO)

- **Profile:** Dr. SAIDI is the Director of the Artificial Intelligence House at ESMT and a prominent member of the GBM (Biomedical Engineering) research laboratory at the University of Tlemcen.
- **Key Competencies:** * Software engineering and AI integration;
 - Cybersecurity and health data protection;

◇ Axis one : Project Presentation

- IT architecture and maintenance.
- **Role within E-SIGNAL:** As the technological pillar of the project, Dr. SAIDI leads the design, development, and continuous improvement of the mobile application and web platform. She manages all technical and IT aspects. Her main mission is to ensure system maintenance, deploy regular updates, and strictly guarantee the security, privacy of hospital data, and high performance of the application.

4. Benzeguire Bendahman – Head of Sales and Institutional Negotiations (B2G)

- **Profile:** Bendahman currently serves as the Director of the Ben Ahmed Mohamed Abdelghani University Residence and possesses extensive prior experience working in hospital administration (Economat).
- **Key Competencies:** * Mastery of hospital inventory procedures and public administration;
 - Contract negotiation and knowledge of public procurement codes;
 - Prospecting and institutional public relations.
- **Role within E-SIGNAL:** With his dual background as a public institution manager and former hospital executive, he is the major asset for acquiring institutional clients. He proactively targets potential clients (public hospitals, university hospital centers). His tasks include negotiating SaaS subscription contracts, adapting commercial offers to public procurement specifications, and facilitating the application's seamless integration with hospital administrative service .

◇ **Axis Two: Innovation Aspects and Technological Foundation**

***Axis Two: Innovation Aspects and
Technological Foundation***

◇ Axis Two: Innovation Aspects and Technological Foundation

Axis Two: Innovation Aspects and Technological Foundation

In an ever-changing global landscape, innovation has emerged as a fundamental strategic lever for corporate development, particularly for startups seeking to address contemporary challenges through novel and adaptive solutions. Innovation is no longer confined solely to advanced technologies; rather, it encompasses a comprehensive set of profound transformations affecting business models, work organization, user experience, and social impact (**Tidd & Bessant, 2020**). For a digital startup, innovation represents the bridge between conceptual potential and operational excellence, enabling the disruption of traditional industry paradigms.

In the public health sector, and more specifically within the management and maintenance of hospital infrastructure, innovation takes on a critical dimension. The increasing complexity of medical equipment, coupled with the urgent necessity for high clinical uptime, imposes a mandatory reform of traditional maintenance approaches (**Kraus et al., 2021**). Conventional methods, often reliant on manual logs and fragmented communication, frequently fail to respond effectively to the immediate needs of medical departments, leading to equipment downtime and compromised patient safety. Faced with these limitations, new initiatives like **E-SIGNAL** emerge, leveraging digital technologies, real-time tracking, and organizational process optimization to improve the accessibility, quality, and flexibility of hospital maintenance services (**WHO, 2021**). This chapter explores the innovative nature of our solution and its systemic impact on the healthcare environment.

◇ Axis Two: Innovation Aspects and Technological Foundation

1-The Nature and Typology of Innovation in Healthcare

1.1 Defining Innovation

In the context of modern business and healthcare management, innovation extends far beyond the mere invention of a new device. It is academically defined as the successful implementation and commercial or operational exploitation of a new idea, product, service, or process that creates tangible value for stakeholders (Tidd & Bessant, 2020). In the digital health ecosystem, innovation is the critical mechanism through which healthcare facilities transition from inefficient legacy systems to agile, data-driven environments (Kraus et al., 2021).

1.2. The Four Dimensions of Innovation

To accurately analyze technological projects, academic literature categorizes innovation into distinct typologies based on the degree of technological novelty and its impact on user behavior and market structures. These can be classified into four primary natures:

1. **Radical Innovation:** This involves the introduction of a completely unprecedented technology that disrupts existing markets and creates entirely new ones (e.g., the introduction of AI-driven robotic surgery).
2. **Technological Innovation:** This occurs when a new technology is deployed to optimize an existing service, without fundamentally altering the core habits of the users (e.g., migrating hospital databases from local physical servers to secure Cloud storage).
3. **Behavioral Innovation:** This type relies on existing, proven technologies but uses them in a novel way to radically change how users consume a service or perform their work (e.g., transitioning from physical consultations to telemedicine using standard video-conferencing tools).
4. **Incremental Innovation:** This represents the continuous, gradual improvement of an existing product or service to enhance its efficiency over time (e.g., updating the user interface of an existing hospital management software).

1.3 Positioning E-SIGNAL:

When applying the innovation matrix to E-SIGNAL, the project follows a strategic, two-phased evolutionary path:

Phase 1: Architectural and Behavioral Innovation (The Current MVP): In its initial deployment, E-SIGNAL is strategically positioned at the intersection of Architectural and Behavioral Innovation. The platform does not invent a new core technology—QR codes and Cloud servers have existed for years. However, its innovative power lies in its architecture:

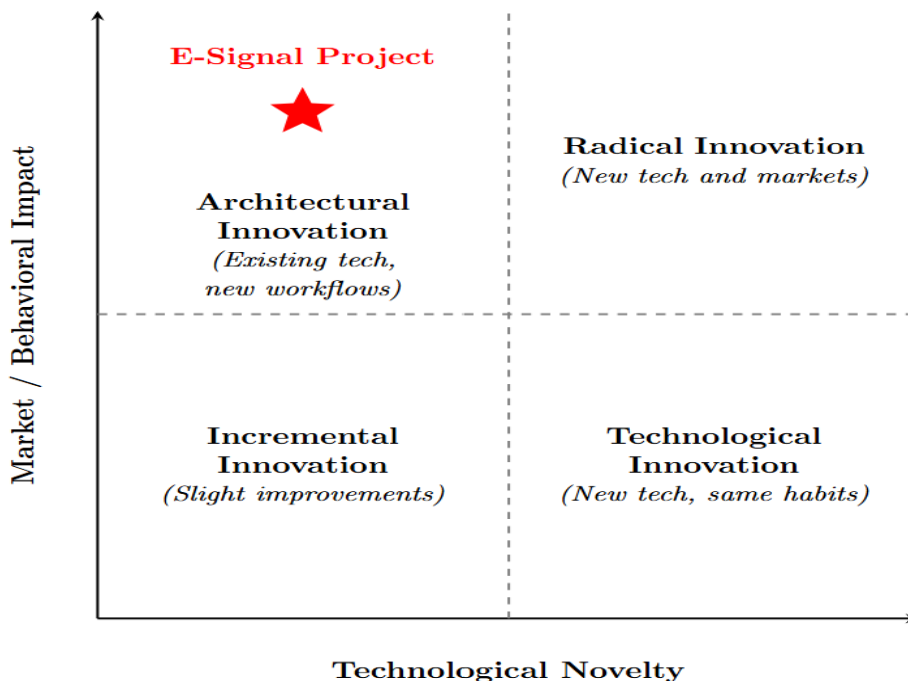
◇ Axis Two: Innovation Aspects and Technological Foundation

combining these existing technologies to disrupt a deeply entrenched, inefficient workflow. By replacing the traditional sequence of "visual identification → phone call → paper logging" with a single, frictionless "Scan and Send" action, E-SIGNAL radically transforms the behavior of the medical staff, drastically reducing reporting time and Mean Time To Repair (MTTR).

Phase 2: Technological Innovation (AI & Predictive Maintenance): To fully align with the deep-tech requirements of the Ministerial Decree 1275 "Innovative Project" matrix, the platform's evolutionary roadmap elevates its core value proposition. E-SIGNAL is designed to transition from simple reactive maintenance (reporting a broken machine) to **Predictive Maintenance** driven by Artificial Intelligence (AI).

In this advanced stage, the platform's algorithms will analyze historical maintenance logs and recurring anomalies. For example, if the system tracks that an infant incubator (e.g., Asset ID: INC-2026) has experienced minor overheating issues three times within a two-month period, the algorithm will not merely generate a routine repair ticket. Instead, it will automatically alert the hospital administration that a core internal component is degrading and requires preemptive replacement before a critical failure occurs. This predictive layer represents a profound **Technological Innovation**, shifting the hospital's operational paradigm from crisis management to strategic, data-driven foresight.

Figure (06) : Positioning of the E-SIGNAL Project in the Innovation Matrix



◇ Axis Two: Innovation Aspects and Technological Foundation

Source: Created by the author for the E-SIGNAL project (2026).

1.4 Key Technological Elements of E-SIGNAL

To fully grasp the operational superiority of E-SIGNAL, it is essential to detail the core technological pillars that construct its ecosystem. This architecture is designed to address the specific constraints of the Algerian healthcare sector:

- **1.4.1. QR Code Integration and Deterministic Identification:** The most critical bottleneck in hospital maintenance is the inaccurate reporting of equipment breakdowns. E-SIGNAL eliminates human error through "Deterministic Identification." By affixing a unique QR code to each piece of medical equipment, the physical device is linked to its digital twin in the database. When a caregiver scans the code, the system automatically retrieves the machine's exact nomenclature, serial number, department, and maintenance history. This "zero-friction" interface reduces the reporting process to under 30 seconds.
- **1.4.2. Cloud-Based SaaS Architecture (Software as a Service):** Unlike legacy Computerized Maintenance Management Systems (CMMS) that require expensive local servers and complex installations, E-SIGNAL operates on a cloud-based SaaS model. This architectural choice provides hospitals with immense flexibility. It allows for continuous remote updates, eliminates the need for hospitals to maintain their own IT server infrastructure, and ensures high availability of the service across various devices (Smartphones, Tablets, PCs).
- **1.4.3. Smart Routing Algorithms and Push Notifications:** E-SIGNAL is not a static database; it is an active routing hub. Once a breakdown is scanned, the platform's algorithm instantly analyzes the equipment category and routes the intervention ticket directly to the appropriate technical department (e.g., Biomedical Engineering vs. General Logistics). This is coupled with real-time Push Notifications sent to the technicians' smartphones, ensuring immediate awareness and drastically reducing the Mean Time to Respond (MTTR).
- **1.4.4. Analytical Dashboards and Data-Driven Governance:** For the hospital administration, the core innovation resides in the automated generation of Key Performance Indicators (KPIs). The management interface aggregates real-time data to display metrics such as equipment availability rates, average repair times, and technician workloads. This transitions the hospital from a reactive management style to proactive, data-driven governance, paving the way for predictive maintenance strategies in the future (World Health Organization, 2021).
- **1.4.5. The Next Technological Milestone: AI-Driven Predictive Maintenance (Phase 2):** While the current fully-programmed Minimum Viable Product (MVP) of

◇ Axis Two: Innovation Aspects and Technological Foundation

E-SIGNAL flawlessly executes reactive maintenance—drastically reducing response times via QR scanning—the strategic roadmap for the platform's future development (Phase 2) integrates Artificial Intelligence (AI).

The vision is to transition from reactive ticketing to **Predictive Maintenance**. In the future, the platform's AI algorithms will analyze historical breakdown data and the frequency of minor anomalies reported by the medical staff. For instance, if the algorithm detects that an infant incubator has been reported for minor overheating three times in two months, the system will automatically alert the Hospital Manager's dashboard. It will predict an imminent critical failure and recommend replacing a specific internal component *before* the machine completely breaks down. This future integration will represent a massive leap in saving public healthcare budgets (CAPEX) and safeguarding patient lives.

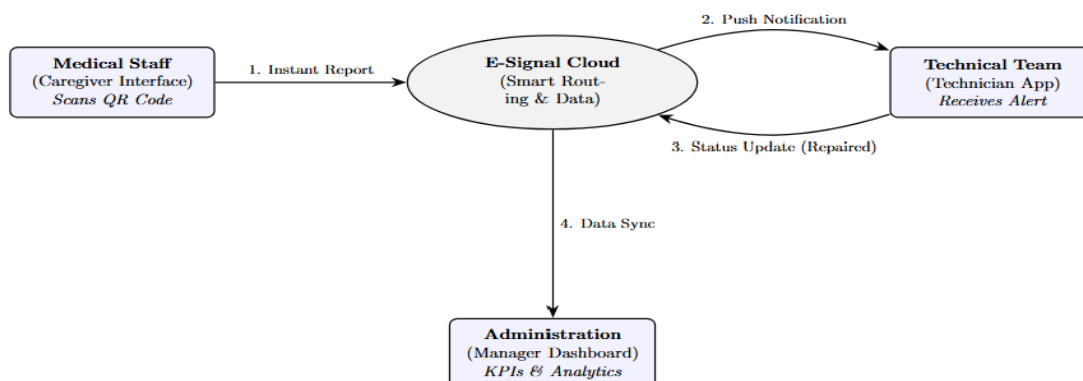
1.5 Technological Architecture: Bridging the Physical and Digital Worlds

To fully grasp the added value of E-Signal, one must analyze its underlying technological architecture, which borrows principles from the **Internet of Medical Things (IoMT)** framework.

1.5.1. The Physical-Digital Bridge (QR Code Integration) The primary bottleneck in medical equipment repair is the inaccurate identification of the faulty device. E-Signal solves this through deterministic identification. The QR Code serves as the physical anchor. When scanned, it queries the centralized database to retrieve the machine's exact nomenclature, serial number, department, and maintenance history. This eliminates the "information deficit" previously identified in our field study.

1.5.2. Cloud-Based SaaS Architecture and Smart Routing Unlike legacy CMMS (Computerized Maintenance Management Systems) that require heavy, local server installations, E-Signal operates on a Software as a Service (SaaS) architecture.

Figure (07) : Functional Architecture and Workflow of the E-SIGNAL Platform



◇ Axis Two: Innovation Aspects and Technological Foundation

Source: Created by the author for the E-SIGNAL project (2026)

As depicted in the operational workflow (Figure \ref{fig:workflow}), the platform functions as a dynamic routing hub. When an alert is generated by the Caregiver Interface, the Cloud engine does not merely broadcast it; it utilizes algorithmic routing to push the notification specifically to the relevant technical department (e.g., Biomedical Engineering vs. General Logistics). This targeted dispatch system is critical for reducing the Mean Time to Respond (MTTR).

2- Domains of Innovation

The technological capabilities of E-Signal trigger a cascade of innovations across several hospital management domains:

- **Process Innovation (From Reactive to Predictive):** E-Signal replaces the fragmented, linear communication chain with a circular, real-time ecosystem. Furthermore, the accumulation of digital maintenance logs paves the way for future *Predictive Maintenance*, allowing hospitals to anticipate equipment failures before they occur based on historical data trends.
- **Organizational Innovation (The Elimination of Silos):** By granting the administration real-time access to operational KPIs (such as technician workload and machine uptime), E-Signal breaks down the traditional "silos" separating clinical, technical, and administrative staff. It fosters a culture of transparency and accountability (Accountability) that is currently lacking in public healthcare facilities.
- **Business Model Innovation (B2G Adaptability):** From a commercial standpoint, E-Signal introduces a flexible subscription-based SaaS model adapted to the strict constraints of the Algerian public procurement system (Business-to-Government). This lowers the financial barrier to entry, allowing hospitals of any size to digitize their maintenance without prohibitive initial capital expenditures.

2.1 Domains of Innovation within the E-SIGNAL Project

Innovation within the E-SIGNAL project is built on several strategic axes aimed at modernizing and optimizing the maintenance management of medical equipment and hospital infrastructure. By combining the integration of agile technologies with a complete overhaul of traditional administrative processes, E-SIGNAL introduces profound structural improvements in the healthcare sector .

2.1.1. Process Innovations (Workflow Reengineering)

◇ Axis Two: Innovation Aspects and Technological Foundation

One of the major innovations of E-SIGNAL lies in the improvement and digitalization of the breakdown reporting and technical intervention processes. Traditionally, reporting a malfunction in a hospital passes through a linear, slow, and often fragmented communication chain involving paper registers, multiple phone calls, and physical movements. E-SIGNAL introduces a significantly more efficient and direct approach:

- **Optimization of Interdepartmental Communication:** The system eliminates administrative bottlenecks. Medical personnel (doctors, nurses) report the breakdown directly from the source, and the information is instantly qualified and transmitted to the competent technical department without any loss of data.
- **Drastic Reduction in Response Time (MTTR):** Through the automation of intervention ticket creation, the delay between detecting a breakdown and notifying a technician is reduced from several hours to mere seconds. This reactivity is crucial in a hospital environment where equipment availability directly impacts patient safety (Tidd & Bessant, 2020).

2.1.2 Technological Innovations

The targeted integration of modern technologies is at the core of the E-SIGNAL model. Unlike traditional Computerized Maintenance Management Systems (CMMS), which are often heavy, expensive, and complex, E-SIGNAL relies on key technological elements that guarantee a "zero-friction" user experience:

- **Deterministic Identification via QR Code:** Each medical device or hospital zone is equipped with a unique QR code. A simple scan using a smartphone eliminates human data entry errors. It instantly retrieves the exact nomenclature of the device, its serial number, and its maintenance history, thereby simplifying the workload for the medical staff.
- **Cloud-Based SaaS Architecture (Software as a Service):** The platform is designed to be intuitive, secure, and accessible across various devices (smartphones, tablets, PCs). This Cloud model exempts hospitals from purchasing and maintaining costly local servers, while ensuring data sovereignty through hosting on secure Algerian servers .
- **Smart Routing Algorithms and Push Notifications:** The system analyzes the nature of the request and automatically routes the intervention ticket to the most qualified technician (e.g., a biomedical engineer for an MRI scanner, or an electrician for lighting issues). Real-time push notifications ensure immediate awareness and action.
- **Analytical Dashboards (Data-Driven Governance):** The application automatically generates Key Performance Indicators (KPIs) in real-time, allowing hospital directors to monitor machine availability rates, track technician performance, and optimize maintenance budgets efficiently.

◇ Axis Two: Innovation Aspects and Technological Foundation

2.1.3 Business Model Innovation (B2G Adaptability):

From a commercial standpoint, E-Signal introduces a flexible subscription-based SaaS model adapted to the strict constraints of the Algerian public procurement system (Business-to-Government). This lowers the financial barrier to entry, allowing hospitals of any size to digitize their maintenance without prohibitive initial capital expenditures.

*Axis Three: Strategic Market Analysis,
Commercial Deployment, and Financial
Viability*

◇ Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability

Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability

1-Market Segmentation (B2B & B2G Approach)

Unlike consumer-facing applications, E-SIGNAL targets institutional healthcare entities. Therefore, the market segmentation shifts from traditional demographics to firmographics and institutional behavior (**Kotler et al., 2021**). To ensure optimal market penetration, the potential client base is divided into structured segments.

1.1. Firmographic Segmentation: The primary segmentation divides the market based on legal status, operational scale, and financial governance. It comprises two main pillars:

- **Public Health Institutions (B2G - Business-to-Government):** This segment includes University Hospital Centers (CHU) and Specialized Hospital Establishments (EHS). These entities manage massive fleets of heavy, life-saving medical equipment under strict public procurement budgets (Marchés Publics). For this segment, equipment downtime represents a critical public health crisis and severe departmental bottlenecks.
- **Private Clinics and Laboratories (B2B - Business-to-Business):** This segment includes private healthcare providers that are highly driven by profitability and operational efficiency. In this sector, equipment downtime directly translates to immediate financial losses and a drop in patient satisfaction. Their decision-making cycles are shorter and heavily focused on Return on Investment (ROI).

1.2. Psychographic and Organizational Segmentation: Our analysis of the Algerian healthcare ecosystem reveals two distinct institutional mindsets regarding digital transformation:

- **The "Early Adopters" (Progressive Management):** Hospital directors and biomedical chiefs who actively seek data-driven governance tools. They perceive digitalization as a strategic asset to optimize public resources and empower their technical teams.
- **The "Traditionalists" (Resistance to Change):** Institutions that remain tethered to obsolete analog methods (paper registers, informal phone reporting). To penetrate this segment, E-SIGNAL's strategy relies heavily on the intuitive simplicity of the QR code scanner, deliberately designed to bypass technological resistance and reduce the users' cognitive load.

1.3. Behavioral Segmentation (The Institutional SONCAS Framework): To trigger institutional adoption and comprehend the psychological drivers of hospital directors and health

◇ Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability

ministries, we mapped their purchasing behaviors using the comprehensive SONCAS framework adapted for HealthTech:

- **Security (Sécurité):** The absolute necessity for Data Sovereignty. Because hospital databases contain highly sensitive information, E-SIGNAL guarantees that all data is hosted locally on Algerian servers, strictly complying with national cybersecurity directives.
- **Pride (Orgueil):** Enhancing the hospital's institutional reputation. By adopting E-SIGNAL, the administration positions itself as a pioneer in the national "E-Health" digitalization strategy.
- **Novelty (Nouveauté):** The disruptive transition from chaotic, obsolete paper-based maintenance logs to a modern, automated, QR-driven digital ecosystem represents a significant and attractive technological leap.
- **Comfort (Confort):** Eliminating operational chaos. The platform eradicates the friction of untraceable phone calls and lost paper tickets, creating a seamless communication channel between medical staff and biomedical engineers.
- **Money (Argent):** Optimizing the overarching maintenance budget (CAPEX/OPEX). By facilitating rapid responses and preventative maintenance, E-SIGNAL prevents critical failures and significantly extends the lifespan of highly expensive medical assets.
- **Sympathy/Relational (Sympathie):** Building institutional trust through a highly responsive, local Algerian support team, alongside an empathetic User Interface (UI) designed specifically to reduce stress for medical staff during emergency situations.

2- Market Sizing and Scalability (TAM, SAM, SOM)

The Algerian healthcare ecosystem represents a vast, untapped market currently undergoing a critical digital transition. To ensure optimal logistical deployment and realistic financial forecasting, the market sizing is structured progressively, utilizing the TAM, SAM, and SOM methodology.

2.1. Definition and Calculation of Market Volumes:

- **TAM (Total Addressable Market):** This encompasses the entirety of the Algerian healthcare sector. Recent data indicates a national network of approximately **915 healthcare establishments** (615 public B2G institutions and 300 private B2B clinics). This represents E-SIGNAL's ultimate long-term vision.
- **SAM (Serviceable Available Market):** This represents the regional scaling phase (Phase 2). It targets the healthcare network across Western Algeria (Oran, Mascara, Mostaganem, Relizane, and Sidi Bel Abbès), comprising **164 healthcare establishments** (93 public and 71 private).

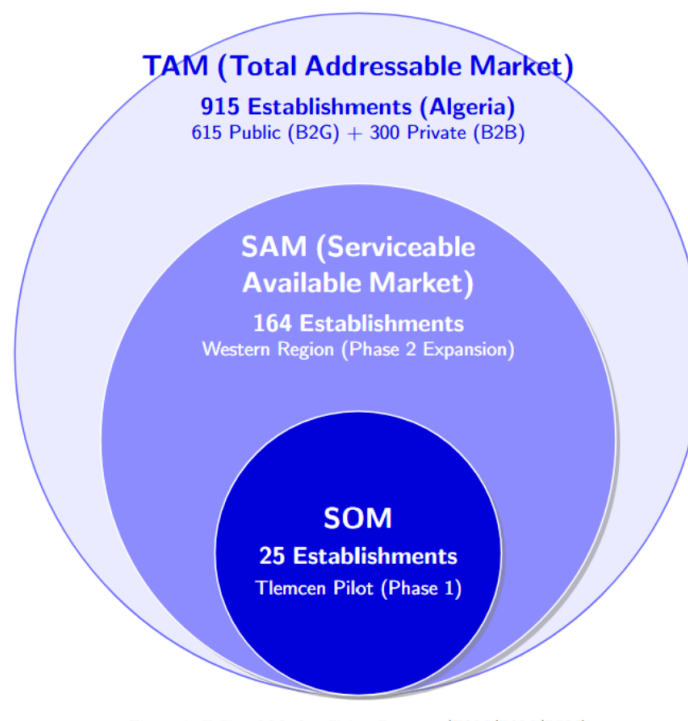
◇ Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability

- **SOM (Serviceable Obtainable Market):** This is the localized operational focus for Phase 1 (The Proof of Concept). The target is the Wilaya of Tlemcen, which houses exactly **21 establishments** (15 public B2G and 6 private B2B).

2.2. Market Penetration Strategy (Year 1): Based on our financial feasibility study, E-SIGNAL aims for a realistic market penetration rate of **40%** within the SOM during its first year of operation.

- **Target Calculation:** 21 establishments $\times$ 40% $\approx$ **8 Active Clients**.
- **Segment Breakdown:** This initial portfolio will consist of **6 Public Institutions** and **2 Private Clinics**, directly correlating with the projected Year 1 turnover of **5,160,000 DA** as established in the financial plan.

Figure (08) : TAM, SAM, and SOM Market Size Estimation for E-SIGNAL



Source: Created by the author for the E-SIGNAL project (2026).

2.3. Assessment of Scalability: This structured sizing model highlights the profound scalability of the E-SIGNAL platform. Transitioning from the SOM (21 entities) to the SAM (164 entities) does not require a proportional increase in fixed costs or physical infrastructure. The cloud-based architecture is designed to absorb the addition of new hospital networks seamlessly, ensuring that as market penetration increases, profit margins grow exponentially.

3-Strategic Differentiation and Competitive Advantage

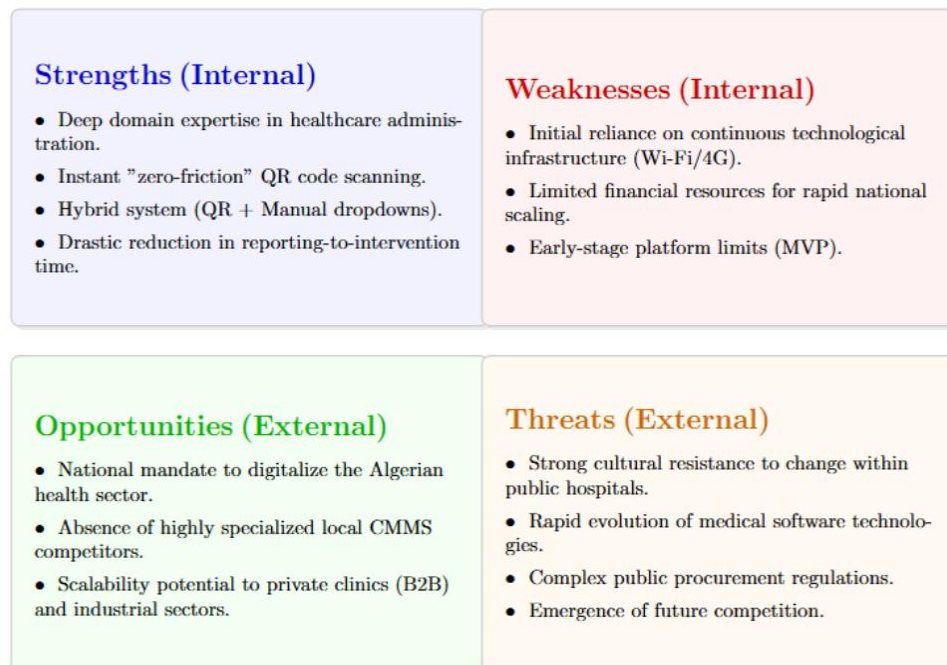
In a market saturated with generic software, E-Signal establishes a robust competitive moat through hyper-specialization. The project's differentiation is anchored in three pillars:

1. **Frictionless UI/UX:** E-Signal bypasses the sluggishness of paper registers and the steep learning curves of traditional CMMS software through instant QR code scanning.
2. **Data Sovereignty and Compliance:** Unlike foreign solutions that host data abroad, E-Signal guarantees absolute data sovereignty via local Algerian hosting, strictly adhering to Ministry of Health security mandates.
3. **B2G/B2B Financial Adaptability:** The economic model is tailored in the local currency (DZD), seamlessly adapting to the rigid constraints of Algerian public procurement.

3.1. Strategic Diagnostic: SWOT Analysis

To systematically map E-SIGNAL's internal capabilities against external environmental factors, a comprehensive SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was conducted. This strategic matrix is vital for identifying the levers of competitive advantage while proactively developing mitigation strategies for potential institutional and technological risks.

Figure (09) : SWOT Analysis of the E-SIGNAL Project



Source: Created by the author for the E-SIGNAL project (2026).

◇ Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability

3.1.1. Strengths (Internal & Positive Factors)

The intrinsic strengths of E-SIGNAL revolve around its specialized technological architecture and its deep alignment with hospital operational realities.

- **Technological Agility and Speed:** The utilization of industrial QR codes allows medical staff to report highly specific equipment breakdowns in under 30 seconds, drastically reducing the Mean Time To Repair (MTTR) without disrupting patient care.
- **Architectural Resilience (Offline Mode):** A profound understanding of hospital infrastructure realities (such as dead Wi-Fi zones in radiology basements) translated into the development of a hybrid interface featuring an "Offline Synchronization" module, ensuring zero data loss during connectivity drops.
- **Regulatory Compliance and Data Sovereignty:** By hosting the platform on local Algerian servers, the startup strictly complies with national security directives regarding the protection of sensitive institutional health data, providing a significant competitive edge over foreign SaaS alternatives.
- **Scalable Cost Structure:** The underlying SaaS architecture inherently possesses low variable costs, allowing for rapid deployment across multiple departments and hospitals without requiring a proportional increase in physical overhead.

3.1.2. Weaknesses (Internal & Negative Factors)

Recognizing internal limitations is critical for a startup in its early scaling phases.

- **Infrastructure Dependency:** Despite the offline synchronization feature, the platform's ultimate efficiency remains partially tethered to the overarching technological infrastructure of the client hospitals (availability of Wi-Fi/4G networks and the quality of the staff's smartphones).
- **Initial Brand Anonymity:** As a newly established entity entering the B2G (Business-to-Government) sector, E-SIGNAL lacks the historical track record that traditional, older maintenance contractors possess, making the initial "Proof of Concept" (PoC) phase in Tlemcen critical for establishing credibility.
- **Resource Constraints for Rapid Scaling:** While the software is scalable, expanding the physical deployment of QR tags and conducting on-site training across all of Western Algeria requires significant human capital and logistical resources that must be carefully managed.

3.1.3. Opportunities (External & Positive Factors)

The macroeconomic and political environment in Algeria presents a highly favorable landscape for HealthTech innovation.

◇ Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability

- **Governmental Digitalization Mandates:** The Algerian government and the Ministry of Health have established explicit directives to digitalize the healthcare sector ("E-Health" initiatives). E-SIGNAL's mission aligns perfectly with this political will, facilitating smoother institutional adoption.
- **Absence of Localized CMMS Competitors:** Currently, there is a distinct market void for specialized, locally hosted Computerized Maintenance Management Systems (CMMS) tailored specifically for the Algerian biomedical sector. Most hospitals still rely on obsolete paper-based workflows.
- **Financial and Institutional Support Ecosystem:** The availability of dynamic funding mechanisms, particularly the Algerian Startup Fund (ASF), provides a viable financial runway to sustain the startup through the long sales cycles typical of the public sector.

3.1.4. Threats (External & Negative Factors)

External threats primarily stem from bureaucratic structures and human behavioral patterns within the target market.

- **Institutional Inertia and Cultural Resistance:** The most critical barrier to entry is the deep-rooted resistance to change among certain hospital administrative staff and older technicians, who may view the transition from familiar paper-based workflows to digital accountability as intimidating or intrusive.
- **Public Procurement Bureaucracy (Marchés Publics):** The administrative complexity and inherent slowness of securing public contracts in the B2G sector can lead to delayed cash flows, testing the startup's financial resilience during the early operational years.
- **Budgetary Constraints in Public Health:** Fluctuations in public spending could lead to frozen hospital budgets, delaying the acquisition of new software solutions despite their proven long-term cost-saving benefits.

3.2.Strategic Macro-Environmental Analysis: PESTEL Framework

To fully comprehend the macro-environmental forces shaping the trajectory of the **E-SIGNAL** platform within the Algerian healthcare sector, a PESTEL analysis is deployed. While consumer-facing applications focus heavily on individual purchasing power, a B2B/B2G HealthTech platform must navigate a complex web of institutional, legal, and infrastructural realities.

The following table adapts the strategic framework to the specific operational realities of digitizing maintenance in Algeria.

Table 03 : PESTEL Analysis for E-SIGNAL in the Algerian Institutional Context

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Dimension	Strategic Analysis for E-SIGNAL (B2B / B2G)
P — Political	- National Digitalization Mandates: The Algerian government exhibits strong political will to modernize public administration ("E-Health" initiatives). - Institutional Support: Active backing from the Ministry of Knowledge Economy and Startups provides a favorable climate for emerging HealthTech solutions.
E — Economic	- Hospital Budget Optimization: E-SIGNAL provides a direct economic benefit by reducing equipment downtime and optimizing capital expenditure (CAPEX). - SaaS Pricing Viability: The subscription model transforms software acquisition from a prohibitive one-time investment into a manageable operational expense (OPEX).
S — Sociocultural	- High-Stress Clinical Environments: The "zero-friction" QR-code reporting system (under 30 seconds) respects the extreme pressure and cognitive load of medical professionals. - Institutional Inertia: A significant cultural challenge is the entrenched reliance on paper registers. Adoption requires overcoming this resistance through extreme UI simplicity.
T — Technological	- Infrastructure Disparities (Dead Zones): Hospital architecture often blocks Wi-Fi/4G. E-SIGNAL neutralizes this via its proprietary Offline Synchronization Module. - Algorithmic Routing: Smart routing algorithms drastically accelerate crisis response times compared to manual ticket dispatching.
E — Environmental	- The "Paperless Hospital": Digitizing maintenance logs significantly reduces the institutional carbon footprint and paper waste. - E-Waste Reduction: Rigorous preventative maintenance extends the lifecycle of heavy biomedical equipment, reducing hazardous electronic waste.
L — Legal	- Data Sovereignty: Compliance with Law 18-07 on personal data protection. Hosting databases locally in Algeria provides a definitive legal advantage over foreign SaaS. - Public Procurement (Code des Marchés Publics): Securing B2G contracts requires rigorous navigation of strict legal bidding processes and defining clear SLAs.

Source: Created by the author for the E-SIGNAL project (2026).

Synthesis of the PESTEL Analysis: The macro-environmental diagnostic reveals that the primary catalysts for E-SIGNAL's growth are highly favorable **Political** and **Legal** landscapes that prioritize data sovereignty and national digitalization.

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The primary barriers are **Sociocultural** (resistance to digital transition) and **Technological** (hospital network infrastructure). By engineering solutions directly targeting these barriers, the highly intuitive QR interface and the offline capability and the platform is strategically positioned to capture and scale within the Algerian healthcare market.

4-Measuring Competitive Intensity and Strategic Positioning

E-SIGNAL operates in a hybrid competitive environment. While direct digital competitors are practically non-existent locally, the startup must navigate against powerful international platforms and deeply entrenched traditional workflows.

4.1. Competitive Benchmark Analysis

To accurately measure the intensity of the competition, the market actors are divided into direct competitors (specialized CMMS software) and indirect competitors (traditional administrative methods).

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Table (04) : Competitive Benchmark of Maintenance Solutions

Category	Actors	Strengths	Weaknesses
Direct Competitors	UpKeep & MaintainX (International CMMS)	- Global market leaders in mobile CMMS. - Advanced features (QR scanning, instant communication).	- Require costly subscriptions in foreign currencies. - Data hosted abroad (Violates Law 18-07 on data sovereignty). - MaintainX is heavily industry-oriented, not hospital-specific.
	SMES (Ministry of Health Software)	- Government-backed public software. - Good for managing broad maintenance contracts and historical archives.	- Lacks mobile agility for instant bedside reporting. - Not designed for rapid, real-time crisis intervention.
Indirect Competitors	Paper Registers & Handwritten Requests	- Deeply rooted in hospital culture. - Highly secure locally (no digital data leaks).	- High risk of data loss or damage. - Zero real-time traceability. - Slows down intervention times significantly.
	Phone Calls & WhatsApp Groups	- Instant communication. - Zero learning curve for staff.	- Information gets easily lost in chaotic chats. - Lack of professional centralization and analytics.
Our Solution	E-SIGNAL	- 100% Data Sovereignty (Local servers). - Instant QR-code reporting (under 30s). - Offline synchronization (dead zones). - Smart routing to on-call technicians.	- Requires initial brand building and trust within the B2G sector. - Needs to overcome initial user resistance to digitalization.

Source: Created by the author for the E-SIGNAL project (2026).

4.2.The Strategic Positioning Map

To visualize E-SIGNAL's market placement against its alternatives, a positioning map is established based on two critical axes for Algerian hospital decision-makers:

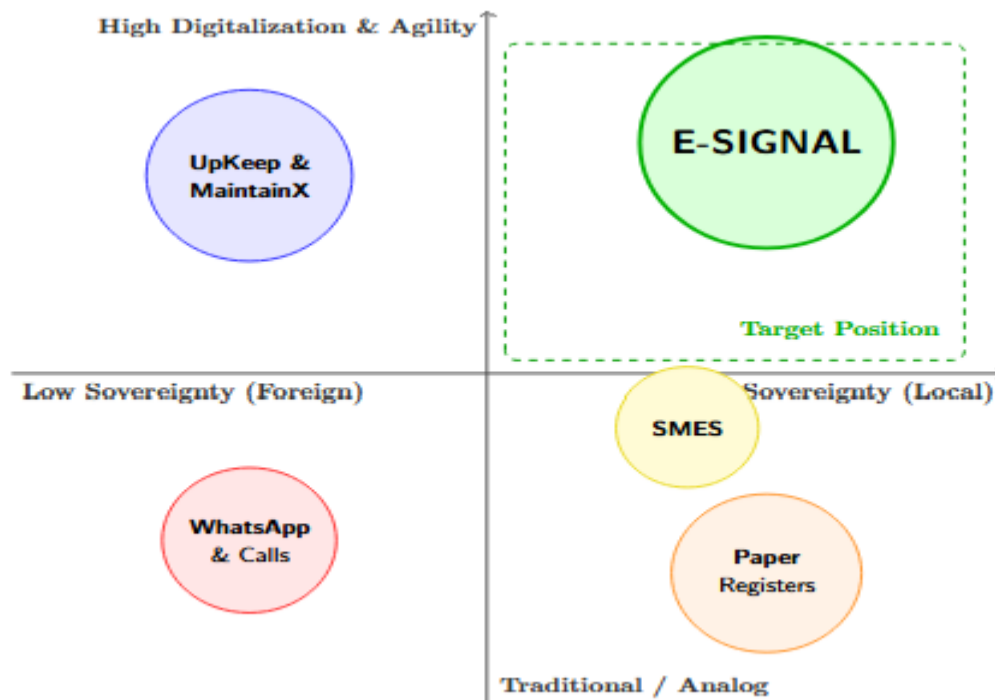
- **Vertical Axis (Y):** Level of Digitalization & Operational Agility (Low to High).

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- **Horizontal Axis (X):** Data Sovereignty & Local Compliance (Foreign/Low to Local/High).

The map demonstrates that E-SIGNAL occupies a highly strategic, uncontested space: the top-right quadrant. While international apps (UpKeep) offer high digitalization, they fail the local compliance test. Conversely, paper registers and the SMES system offer high local compliance but lack modern mobile agility. E-SIGNAL bridges this exact gap.

Figure (10) : Competitive Positioning Matrix of E-SIGNAL



Source: Created by the author for the E-SIGNAL project (2026).

4.3. Competitive Differentiation: What Sets E-SIGNAL Apart

Based on the strategic mapping, E-SIGNAL establishes a strong competitive moat through the following Unique Selling Propositions:

- **Exclusive Healthcare Specialization:** Unlike MaintainX, which caters heavily to industrial factories, E-SIGNAL is engineered exclusively for the Algerian biomedical environment, understanding the specific urgency of ICU and surgical equipment.
- **The "Offline Synchronization" Failsafe:** A critical technological advantage that allows technicians to process tickets in hospital basements without Wi-Fi, automatically syncing data once connectivity returns.

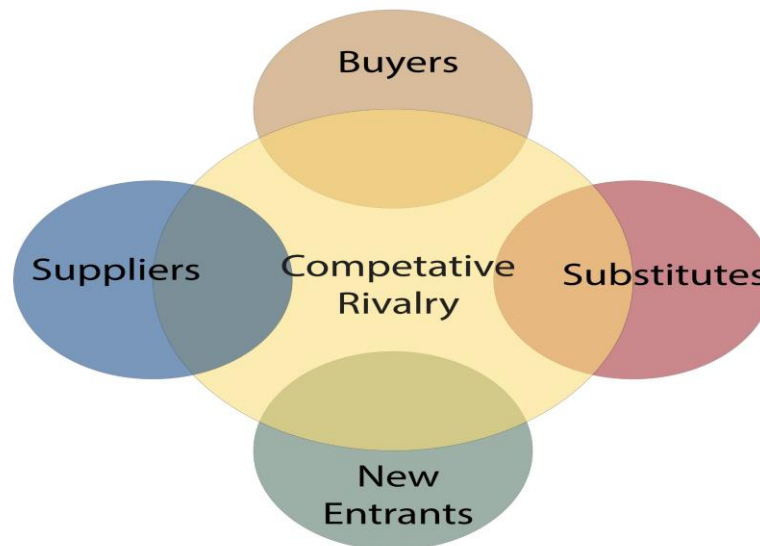
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- **Frictionless QR Code Reporting:** Bypassing the slow, bureaucratic nature of the SMES system or handwritten notes by enabling medical staff to trigger a precise maintenance alert in under 30 seconds.
- **Absolute Regulatory Compliance:** By hosting all infrastructure on local Algerian servers, the platform guarantees total data sovereignty, aligning perfectly with Law 18-07 and neutralizing the primary weakness of foreign leaders like UpKeep.

4.4.Strategic Industry Analysis: Porter's Five Forces + 1

To assess the fundamental attractiveness and competitive dynamics of the biomedical maintenance software market in Algeria, Michael Porter's Five Forces framework is utilized, supplemented by a crucial sixth force: The Role of Public Authorities (Porter, 1979). This model evaluates the balance of power within the E-SIGNAL ecosystem.

Figure (11) : Porter's Five Forces Analysis
The Porter's 5 Forces Model



Source: Created by the author for the E-SIGNAL project (2026).

4.4.1. Intensity of Competitive Rivalry (Low to Moderate)

- **Market Reality:** The Algerian B2G market for hospital Computerized Maintenance Management Systems (CMMS) is currently highly fragmented and underdeveloped. The primary "competitors" are outdated legacy systems (like the government's SMES) which lack mobile agility, and foreign SaaS platforms (like UpKeep) which violate local data sovereignty laws.
- **Strategic Implication:** E-SIGNAL operates in essentially a market space free of fierce direct competition.

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- **Recommended Strategy:** Capitalize on this "First-Mover Advantage." By aggressively securing early contracts (starting with the Tlemcen Pilot), E-SIGNAL can establish itself as the national standard for hospital maintenance before other local tech companies recognize the market gap.

4.4.2. Threat of New Entrants (Low to Moderate)

- **Market Reality:** Unlike simple consumer apps, the barriers to entry in the public HealthTech sector are high. Developing a platform requires not just coding skills, but a profound understanding of complex hospital workflows, offline synchronization engineering, and navigating the highly bureaucratic public procurement network (Code des Marchés Publics).
- **Strategic Implication:** While a new tech startup could theoretically copy the software, they cannot easily replicate the institutional trust and B2G relationships E-SIGNAL is building.
- **Recommended Strategy:** Create high "**Switching Costs**". Once a hospital integrates E-SIGNAL, labels all its equipment with our QR codes, and trains its staff, the organizational friction required to switch to a new competitor later becomes too high, ensuring long-term "Vendor Lock-in."

4.4.3. Bargaining Power of Buyers (High)

- **Market Reality:** The buyers are Hospital General Directors (CHU, EHS) and the Ministry of Health. Because they represent massive public institutions with strict budgets and are naturally risk-averse regarding operational changes, their bargaining power is extremely high. They dictate the terms of procurement.
- **Strategic Implication:** Buyers will demand bulletproof guarantees regarding data security, system uptime, and cost-efficiency before abandoning their traditional methods.
- **Recommended Strategy:** Deploy Account-Based Marketing (ABM) backed by empirical data. Use the Tlemcen Pilot to prove a tangible reduction in MTTR. Furthermore, mitigate the buyers' perceived risk by offering strict **Service Level Agreements (SLAs)** and an OPEX-friendly SaaS subscription model that avoids heavy initial capital expenditure (CAPEX).

4.4.4. Bargaining Power of Suppliers (Moderate)

- **Market Reality:** For a SaaS startup like E-SIGNAL, the primary suppliers are not traditional physical manufacturers, but **Local Data Centers and Cloud Hosting Providers** (e.g., ICOSNET, Djaweb), alongside the manufacturers of the physical QR code tags. Because E-SIGNAL *must* host data locally to comply with Law 18-07, it cannot simply use cheaper international giants like Amazon Web Services (AWS) or Google Cloud.

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- **Strategic Implication:** Relying on a limited pool of local, compliant data centers gives those specific suppliers a moderate degree of bargaining power regarding hosting fees.
- **Recommended Strategy:** Adopt a multi-server strategy if possible, negotiating long-term enterprise contracts with local hosting providers to secure fixed infrastructure costs and guarantee the 99.9% uptime promised to hospital clients.

4.4.5. Threat of Substitute Products (High)

- **Market Reality:** The greatest threat does not come from another software, but from the "Status Quo". Hospital staff can easily substitute E-SIGNAL with informal, deeply ingrained habits: making direct phone calls to technicians, sending messages in chaotic WhatsApp groups, or scribbling in paper registers.
- **Strategic Implication:** If the E-SIGNAL app is even slightly complicated or slow, doctors will immediately revert to their old substitutes.
- **Recommended Strategy:** Uncompromising focus on User Experience (UX). The sole defense against informal substitutes is ensuring that scanning an E-SIGNAL QR code is tangibly faster and easier (under 30 seconds) than typing a WhatsApp message or searching for a paper logbook.

4.4.6. The "+1": Role of Public Authorities / The State

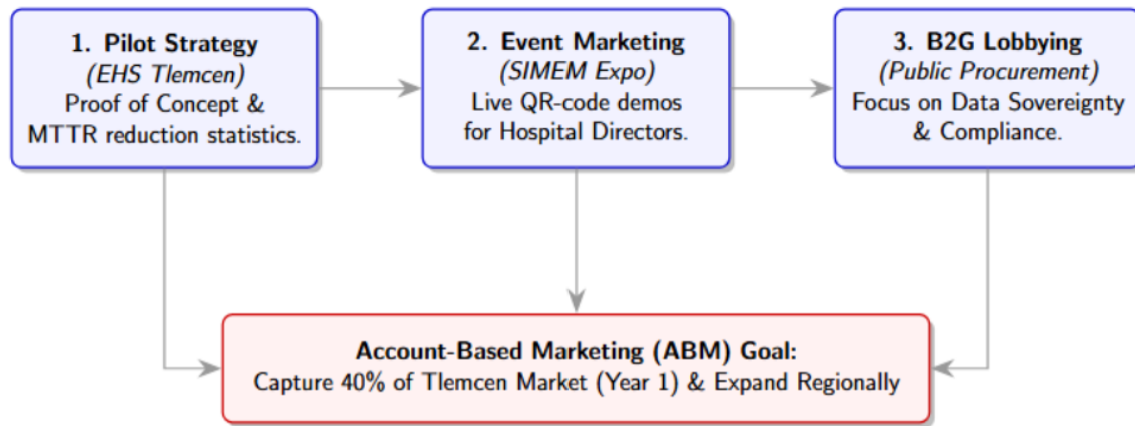
- **Market Reality:** In the Algerian healthcare sector, the government is not just a regulator; it is the primary financier, rule-maker, and ultimate client. The State's directives on "E-Health," healthcare digitalization, and personal data protection (Law 18-07) shape the entire industry landscape.
- **Strategic Implication:** A single decree from the Ministry of Health mandating digital maintenance tracking could instantly scale the startup nationally. Conversely, a failure to secure public procurement compliance could block market entry entirely.
- **Recommended Strategy:** Institutional Lobbying. E-SIGNAL must proactively align its brand narrative with the government's digital transformation goals. By positioning the startup as a sovereign, compliant, and innovative partner to the State (supported by initiatives like the ASF - Algerian Startup Fund), E-SIGNAL transforms the government from a regulatory hurdle into its most powerful catalyst for growth.

5- The Marketing Strategy (B2B / B2G Focus)

Given the strictly institutional nature of the E-SIGNAL platform, traditional mass-market advertising (B2C) is entirely ineffective. Instead, the startup will deploy a highly targeted Account-Based Marketing (ABM) strategy (Kotler et al., 2021). ABM treats each prospective hospital or clinic as its own unique market, focusing resources on engaging specific high-level decision-makers, such as Hospital General Directors, Biomedical Department Heads, and regional Health Directors (DSP).

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Figure (12) : B2B/B2G Go-to-Market Strategy and Account-Based Marketing Workflow



Source: Created by the author for the E-SIGNAL project (2026).

To successfully capture 40% of the Tlemcen market in Year 1 and establish a foundation for regional expansion, the ABM strategy is operationalized through three distinct, sequential phases:

5.1. The Pilot Strategy: Creating a Data-Backed Proof of Concept (PoC)

The public healthcare sector is naturally risk-averse. To overcome this, E-SIGNAL's initial market penetration relies on establishing a localized "Success Story."

- **The Tlemcen EHS Pilot:** By offering a controlled, risk-free pilot phase to a major local institution (such as an EHS in Tlemcen), the startup can seamlessly integrate the platform into real-world hospital workflows.
- **Generating Empirical Evidence:** The primary objective of this pilot is not immediate revenue, but data acquisition. By documenting tangible operational improvements—most notably the drastic reduction in **Mean Time To Repair (MTTR)** and the optimization of equipment uptime—E-SIGNAL builds an empirical, data-backed business case. This documented PoC becomes the ultimate marketing asset to convince subsequent, more skeptical hospital directors that the ROI is guaranteed.

5.2. Event Marketing: Experiential Demonstration at SIMEM

Healthcare administrators need to experience the simplicity of digital tools before committing to them. Experiential marketing will be a cornerstone of the acquisition strategy.

- **Targeted Exhibitions:** A physical presence at major specialized events, particularly the **International Medical Equipment Exhibition (SIMEM)** held annually in April, places E-SIGNAL directly in front of the nation's top healthcare purchasers and suppliers.

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- **Live Interactive Demos:** The marketing tactic here shifts from "telling" to "showing." By allowing hospital directors to physically scan a QR code on the exhibition floor and instantly see a simulated maintenance ticket appear on the manager's dashboard, the abstract concept of "digitalization" becomes an immediate, tangible reality.
- **Strategic Logistical Support:** The execution of these large-scale event demonstrations benefits significantly from robust logistical coordination. Leveraging academic networks and enthusiastic student cohorts—such as those from the Higher School of Management—to serve as trained brand ambassadors on the exhibition floor ensures broad coverage, dynamic engagement, and seamless demonstration delivery to passing decision-makers.

5.3. Institutional Lobbying and the B2G Sales Narrative

When marketing directly to the government and public health sector (B2G), the traditional sales pitch regarding "features" must be elevated to a narrative of "compliance and governance."

- **Focus on Data Sovereignty:** The core of the lobbying effort will center on national security. By heavily promoting the fact that E-SIGNAL is hosted entirely on local Algerian servers, the marketing narrative assures hospital directors that they are in strict compliance with the Ministry of Health's directives on safeguarding sensitive institutional data.
- **Alignment with National Digitalization Goals:** The sales approach is framed as a strategic partnership rather than a software purchase. E-SIGNAL is positioned as the definitive tool to help hospital administrations effortlessly achieve the government's mandate for "E-Health" and paperless administration. By mitigating the perceived political and administrative risks for hospital directors, this narrative drastically shortens the typically long public procurement cycles.

As part of the development of the **E-SIGNAL** platform, an in-depth analysis of the marketing strategy is essential to ensure its success in the Algerian institutional market (B2B / B2G). To meet the complex and specific requirements of the **hospital maintenance and medical equipment management** sector, we have adopted an integrated approach. This combines the classic **4P marketing mix model (Product, Price, Place, Promotion)** with **modern technological elements tailored for SaaS solutions: 2P (Personalization, Privacy/Data Protection), 2C (Customer Service, Community), and 3S (System/App, Security, Sales Promotion).**

The matrix below breaks down each component of this strategy across the four stages of the platform's life cycle—**Launch, Growth, Maturity, and Decline**—ensuring that marketing actions are adapted to the realities of the Algerian healthcare infrastructure and the strict requirements of data sovereignty. This holistic approach guarantees a consistent, scalable value proposition that is perfectly aligned with the needs of biomedical engineers, hospital directors, and regulatory authorities (DSP, Ministry of Health).

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Table (05) : Application of the 4P+2P+2C+3S Marketing Mix to Each Phase of the E-SIGNAL Life Cycle

Element	Launch	Growth	Maturity	Decline
Product	MVP focused on Core CMMS, Technician App, and Offline Sync module.	Integration of AI for predictive maintenance and MTTR analytics.	Full ERP integration with automated procurement APIs.	Streamlining to essential legacy maintenance functions.
Price	Subsidized PoC to prove ROI, shifting costs from CAPEX to OPEX.	Tiered SaaS subscriptions based on hospital capacity.	Multi-year B2G enterprise contracts with strict SLAs.	Reduced fees for legacy maintenance contracts.
Place	On-site deployment and physical QR tagging in Tlemcen (Pilot).	Regional B2B expansion via direct technical sales teams.	National deployment integrated with the Ministry of Health.	Digital-only remote support and legacy access.
Promotion	Account-Based Marketing (ABM) and demos at SIMEM Expo.	Data-backed case studies and B2B webinars on budget optimization.	PR on national health impact and official government endorsements.	Targeted retention communication only.
Personalization	Custom QR hierarchies and specific department routing.	Custom role dashboards (e.g., DSP vs. Head of ICU).	AI-generated reports tailored to specific Ministry KPIs.	Standardized, automated reporting.
Privacy	Strict Law 18-07 compliance with 100% local server hosting.	Advanced Role-Based Access Control (RBAC) and data encryption.	ISO 27001 Certification and deep B2G compliance audits.	Secure data archiving and strict retention policies.
Customer Service	On-site physical training and 24/7 dedicated technical hotlines.	Dedicated Account Managers for regional hospital clusters.	Strict SLAs legally guaranteeing 99.9% platform uptime.	Automated ticketing support systems.
Community	Focus groups with local Tlemcen biomedical engineers.	B2B user groups and digital health symposiums.	National network of certified E-SIGNAL technicians.	Minimal engagement via core institutional

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				channels.
System (App)	Zero-friction UI (under 30s scan) with high-contrast clinical design.	Cross-platform interoperability and smart push notifications.	Seamless legacy system data migration tools.	Lite version focused purely on server stability.
Security	End-to-end encrypted logins and secure local network mapping.	Regular vulnerability penetration testing (Pen-Tests).	Institutional firewall integrations.	Phased secure decommissioning protocols.
Sales Promos	Free hardware tagging (QR stickers) during the pilot phase.	Volume discounts for regional health directorates (bulk adoption).	Up-selling premium analytics modules.	Contract renewal incentives.

Source: Created by the author for the E-SIGNAL project (2026).

5.4.Detailed Explanation of the Marketing Mix Components

5.4.1. Product (The Technological Core)

In a B2B/B2G HealthTech environment, the "Product" is not merely an application, but an integrated ecosystem designed to solve complex institutional bottlenecks. Its evolution is strictly dictated by operational feedback and technological scalability.

- **Launch (Phase de Lancement):** The strategy centers on deploying a highly focused **Minimum Viable Product (MVP)**. To test the market and ensure rapid adoption among technically resistant staff, the MVP is stripped of unnecessary complexities. It includes only the absolute essentials: the core CMMS ticketing system, industrial QR code generation for medical equipment, the dedicated Technician App, and the critical **Offline Synchronization module** (ensuring functionality in hospital basements and radiology dead zones).
- **Growth (Phase de Croissance):** Once the core workflow is validated by the pilot institution, the platform expands its capabilities. The focus shifts from reactive maintenance to intelligent oversight. Features added include real-time MTTR (Mean Time To Repair) analytics dashboards tailored for hospital directors, AI-driven predictive maintenance alerts, and digital inventory tracking for spare parts.
- **Maturity (Phase de Maturité):** The product reaches its peak operational complexity. User Experience (UX) is highly optimized for institutional scale. E-SIGNAL transforms into a comprehensive HealthTech module with full ERP (Enterprise Resource Planning) integration. It includes automated procurement APIs that alert the administration when

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spare parts are low, and seamless ecosystem integration with the broader Ministry of Health databases.

- **Decline / Legacy (Phase de Déclin):** As newer technologies emerge or the platform transitions to a next-generation architecture, the legacy product undergoes feature reduction. Complex analytics are phased out, preserving only the most utilized, essential core services (basic QR ticketing and technician routing) to maintain server stability and reduce technical debt for remaining active users.

5.4.2. Price

Pricing a B2G software requires navigating strict public hospital budgets and the bureaucratic complexities of the *Code des Marchés Publics*. The strategy hinges on shifting the financial burden from prohibitive capital expenditures (CAPEX) to manageable operational expenses (OPEX).

- **Launch:** To overcome the immense institutional barrier to entry, the initial pricing strategy acts as a "loss leader." For the pilot phase (e.g., at the Mother and Child Hospital), E-SIGNAL offers a heavily subsidized or free **Proof of Concept (PoC)**. By providing the QR hardware stickers at no cost, the goal is to eliminate financial friction, encourage immediate institutional trial, and generate the empirical ROI data required for future sales.
- **Growth :** Having proven its effectiveness through documented MTTR reduction and equipment lifespan extension, the startup introduces a **Tiered SaaS Subscription Model**. Pricing is scaled progressively based on the hospital's capacity (e.g., number of beds, volume of tagged biomedical equipment). The administration accepts this higher OPEX cost because the perceived and proven value—saving millions in avoided equipment replacement—vastly outweighs the subscription fee.
- **Maturity:** Pricing stabilizes into highly lucrative, long-term stability. The startup secures **Multi-Year B2G Enterprise Contracts**. These contracts are bundled with premium loyalty packages, including priority 24/7 technical support, strict Service Level Agreements (SLAs) with financial guarantees, and early access to predictive AI modules.
- **Decline / Legacy:** To minimize churn (abandonment rate) among institutions resistant to upgrading to newer systems, pricing is significantly reduced. Low-cost "Legacy Maintenance Contracts" are offered, ensuring steady, passive revenue from the existing user base while the startup focuses its primary resources on its next innovation cycle.

5.4.3. Place

To ensure the successful adoption of the E-SIGNAL platform within the highly bureaucratic Algerian healthcare system, the distribution strategy must evolve from a highly localized, physical intervention to a fully automated, digital infrastructure. In a B2G HealthTech context, distribution does not mean uploading an app to a public store; it requires secure institutional deployment.

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- **Launch:** Distribution is entirely **physical and on-site**. For the initial pilot at the Mother and Child Hospital in Tlemcen, the startup team must be physically present to map the hospital's infrastructure, attach the industrial QR codes to the biomedical equipment, and directly install the Technician App on the staff's devices.
- **Growth:** As the Proof of Concept (PoC) is validated, distribution scales across the region. The centralized Web Portal (the dashboard for hospital directors) becomes the primary distribution hub for management. Support transitions from on-site training to dedicated Account Managers. Professional B2B networks (such as LinkedIn) and specialized medical exhibitions are utilized as primary channels to reach other hospital directors.
- **Maturity:** Physical, hospital-by-hospital deployment becomes unsustainable at a national scale. At this stage, distribution transitions into **API Integration**. E-SIGNAL interfaces directly with the central IT systems of the Ministry of Health, allowing for remote, centralized deployment of the software framework to any newly contracted hospital across the country.
- **Decline:** Physical deployments and active expansion are completely halted. Distribution is restricted to maintaining secure cloud server access and providing digital technical support for existing clients under legacy maintenance contracts.

Table (06) : Evolution of E-SIGNAL Distribution Channels Across the Product Life Cycle

Distribution Channel (B2B/B2G)	Launch	Growth	Maturity	Decline
Physical On-Site Deployment	Active	Active	Reduced	Removed
Technician Mobile App	Active	Active	Active	Active
Web Portal (Director Dashboard)	In Dev.	Active	Active	Active
Professional Networks (LinkedIn)	Active	Active	Active	Removed
Dedicated Account Manager	Active	Active	Active	Reduced
API Integration (Ministry)	Not Used	In Dev.	Active	Active

Legend:

Active: Primary channel fully utilized.

In Dev. / Reduced: Channel currently under development or usage is scaled back.

Removed / Not Used: Channel is inactive or abandoned.

Source: Created by the author for the E-SIGNAL project (2026).

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Analysis of the Distribution Channels Matrix (Place):

This table illustrates the strategic evolution of E-SIGNAL's deployment channels across its lifecycle. In the B2G public health sector, distribution transcends simple app downloads; it requires profound systemic and technical integration within the hospital environment.

- **Physical On-Site Deployment:** Fully active during the Launch phase (e.g., the Tlemcen Pilot) to physically attach QR codes and conduct face-to-face training, breaking down technological resistance. It is scaled back during Maturity as national physical expansion becomes too costly.
- **Technician Mobile App:** The only channel that remains fully active throughout the entire product lifecycle, serving as the indispensable daily interface for hospital maintenance engineers.
- **Web Portal (Director Dashboard):** Initially "In Development" while the focus remains on engineers. It became the primary active platform during Growth and Maturity, enabling Hospital Directors and Regional Health Directorates (DSP) to centrally monitor KPIs like MTTR.
- **Professional Networks (LinkedIn):** Utilized as an institutional B2B distribution channel to reach decision-makers. It is removed during the Decline phase when the acquisition of new clients ceases.
- **Dedicated Account Manager:** In the B2G model, after-sales support acts as a core distribution channel. It guarantees service stability, rapid human support, and strict compliance with Service Level Agreements (SLAs).
- **API Integration (Ministry of Health):** This represents the pinnacle of institutional maturity. Initially "Not Used," it later enables the fully digital, remote deployment of E-SIGNAL to any new hospital in Algeria, eliminating the need for expensive on-site visits.

5.4.4. Promotion (Communication & Acquisition)

Mass marketing tactics—such as social media influencers or flyers used in B2C apps—are entirely ineffective in the B2G sector. Hospital directors are convinced by data, compliance, and peer validation. The promotional strategy must reflect this institutional rigor.

- **Launch:** Communication is laser-focused using **Account-Based Marketing (ABM)**. The startup targets specific high-level decision-makers. The primary promotional vehicle is experiential: conducting live, simulated crisis-response demonstrations at specialized medical trade shows, notably the **International Medical Equipment Exhibition (SIMEM)**, to physically show directors the sub-30-second reporting speed.
- **Growth :** The promotional narrative shifts from "features" to "empirical results." E-SIGNAL utilizes data-backed storytelling, publishing case studies detailing the exact reduction in MTTR achieved during the Tlemcen pilot. Communication channels include

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B2B webinars aimed at hospital administrators focusing on Optimizing Hospital CAPEX/OPEX through Digital Maintenance.

- **Maturity:** Promotion relies heavily on institutional reputation. The startup leverages official government endorsements and highlights its ISO certifications and Law 18-07 compliance. Strategic Public Relations (PR) campaigns focus on the platform's macro-impact on the national healthcare system, emphasizing data sovereignty and improved patient care continuity.
- **Decline / Legacy:** Outbound marketing and acquisition campaigns are completely halted. Communication is minimal and strictly targeted at the existing user base. It focuses solely on retention, system updates, and reaffirming adherence to Service Level Agreements (SLAs).

5.4.5. Personalization Strategy

- **Launch: Functional Routing.** Personalization is focused on operational workflows. When a nurse scans an asset, the system bypasses complex menus to instantly personalize the alert to the specific technician assigned to that hospital wing.
- **Growth: Role-Centric Dashboards.** The UI diverges based on institutional hierarchy. Technicians receive mobile-first schematics, while hospital administrators unlock high-level web dashboards for tracking financial KPIs and team efficiency.
- **Maturity: Macro-Level Predictive Insights.** Personalization scales regionally, providing Regional Health Directorates (DSP) with AI-generated reports that forecast which hospital assets will require priority budget allocations for the following fiscal year.
- **Decline: Standardization.** Development of custom dashboards is frozen. The platform reverts to standardized, automated reporting templates to ensure maximum server stability and operational efficiency.

5.4.6. Protection (Privacy & Data Security)

- **Launch: Foundational Trust.** To neutralize institutional skepticism, the pilot phase enforces 100% local server hosting and end-to-end encrypted authentication, ensuring immediate and absolute data sovereignty.
- **Growth: Network-Wide Governance.** As the ecosystem expands across departments, we deploy advanced Role-Based Access Control (RBAC) to ensure personnel only access data relevant to their specific institutional clearance level.
- **Maturity: The Sovereign Moat.** Security transitions from a feature to the primary strategic advantage, cemented by ISO 27001 certification and audited compliance with the mandate of Algerian Law 18-07.
- **Decline: Secure Archiving.** Active penetration testing is decelerated. Resources are redirected toward maintaining firewall integrity, secure long-term data archiving, and strictly compliant data retention protocols.

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5.4.7. Customer Service Strategy

- **Launch: High-Touch Human Onboarding.** To mitigate technological resistance, service is intensely physical. We provide on-site "bedside" training to ensure the platform is perceived as tangibly easier than existing informal methods.
- **Growth: Proactive Account Management.** Reactive helpdesks are replaced by dedicated B2B Account Managers. These specialists provide proactive advice to regional clusters on asset optimization before critical equipment failures manifest.
- **Maturity: Contractual Reliability (SLAs).** Customer service is institutionalized into legally binding Service Level Agreements. We transition from selling "support" to legally guaranteeing 99.9% platform uptime to hospital administrations.
- **Decline: Automated Autonomy.** Human-led support is significantly scaled back. Legacy users are transitioned toward comprehensive digital knowledge bases and automated ticketing systems for essential bug fixes.

5.4.8. System (The Technological Engine)

- **Launch (Frictionless MVP):** The architecture is built for extreme speed. The primary requirement is a "Zero-Friction UI"—scanning a QR code must take under 30 seconds, even in poor network conditions (e.g., hospital basements), to outcompete informal, manual workarounds.
- **Growth (Interoperability):** The system matures into a modular platform capable of bidirectional data flow. It moves beyond isolated CMMS ticketing and begins integrating with legacy hospital information systems (HIS) and ERPs.
- **Maturity (National Integration):** The system becomes a hardened, scalable cloud infrastructure. It supports high-concurrency usage across the national network, providing Ministry-level analytics and predictive maintenance modeling.
- **Decline (Legacy Stability):** Development freezes. The system shifts into "Maintenance Mode," focusing solely on server stability, security patching, and ensuring legacy data remains accessible and archived according to regulatory standards.

5.4.9. Community (Professional Standard-Setting)

- **Launch:** We engage local Tlemcen biomedical engineers as co-creators. Their feedback is not just "user input"; it is the foundation of the platform's professional credibility.
- **Growth:** We evolve the community into a professional symposium. By fostering B2B user groups and HealthTech webinars, we transition from being a software vendor to being a partner in advancing the profession of biomedical engineering in Algeria.
- **Maturity:** The community achieves critical mass. E-SIGNAL is no longer just a tool; it becomes the standard-bearer for digital hospital management. We formalize the network

◆ Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability

into a national repository of best practices, where engineers share compliant maintenance workflows.

- **Decline:** Community outreach ends. Engagement is reduced to passive communication via institutional channels, maintaining the platform as a reference tool for the remaining legacy base without active expansion or event-driven interaction.

6. Financial Projections and Economic Viability

The financial study of E-SIGNAL translates the strategic vision into quantitative metrics. Operating as a Software as a Service (SaaS), the project's financial structure is characterized by low variable costs and high scalability (Blank & Dorf, 2020).

6.1. Investment Structure & Financing: The total initial investment required is 890,000 DZD. This covers application development (200,000 DZD), hardware, legal fees, and a dedicated starting treasury of 100,000 DZD to ensure operational liquidity. Financing is highly stable: 250,000 DZD is secured through personal contributions (Apport Personnel), while the remaining 640,000 DZD is projected to be funded through governmental startup support mechanisms (ASF). This hybrid structure mitigates personal financial risk while crossing the startup "Valley of Death" (Ries, 2011).

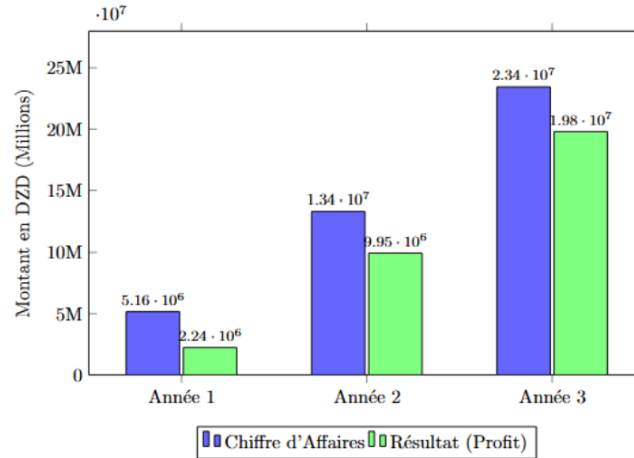
6.2. Revenue Model & Market Penetration: The pricing strategy includes installation fees (300,000 DZD for B2G; 280,000 DZD for B2B) and annual recurring revenue (250,000 DZD for B2G, legally structured as an IT Maintenance & Support Contract to comply with public procurement laws; and 230,000 DZD for B2B as a standard SaaS subscription). By acquiring a 40% market share in Tlemcen during Year 1 (6 public, 2 private establishments), the projected gross revenue (Chiffre d'Affaires) is 5,160,000 DZD.

6.3. Operating Costs Framework: Human resources represent the primary operational cost, with salaries and social charges for the core team (Manager, Marketer, Developer) totaling 2,754,000 DZD in Year 1. Conversely, fixed costs (Internet, Insurance, Marketing) remain remarkably low at 151,600 DZD annually, demonstrating the operational efficiency of the platform.

6.4. Profitability and Scalability (TCR): The SaaS model demonstrates exceptional profitability. In Year 1, the projected net result before taxes is profoundly positive at 2,236,000 DZD. As regional expansion initiates in Years 2 and 3, revenue scales exponentially to 13,350,000 DZD and 23,442,200 DZD, respectively. Because fixed costs and salaries grow at a much slower rate than software subscriptions, the net profit is projected to reach 19,799,200 DZD by Year 3. This exponential growth validates the massive scalability of architectural innovation in healthcare (Gassmann et al., 2020).

◇ **Axis Three: Strategic Market Analysis, Commercial Deployment, and Financial Viability**

Figure (13) : Three-Year Financial Projections (Revenue and Profit) for the E-SIGNAL Startup



Source: Created by the author for the E-SIGNAL project (2026).

***Axis Four: Production and Organization
Plan***

◇ Axis Four: Production and Organization Plan

Axis Four: Production and Organization Plan

In this fourth chapter, we will detail how the project will be concretely implemented on the ground. This involves presenting the internal organization, the human and technical resources mobilized, as well as the necessary steps for the production and delivery of the service. This plan ensures that the resources are properly aligned with the project's objectives, and that the activity can be launched and managed in an efficient and structured manner

◇ Axis Four: Production and Organization Plan

1- Production and Delivery Process of E-SIGNAL

The operational implementation of E-SIGNAL is divided into two distinct but complementary phases: the technical production of the software solution and the actual delivery process of the maintenance service within the hospital environment.

1.1 The Production Process (Software & Implementation)

Unlike traditional physical services, the production of E-SIGNAL follows a rigorous Software Development Life Cycle (SDLC) tailored for HealthTech:

- Phase 1: Architecture and Initial Development:
 - Designing the secure Cloud architecture to host sensitive hospital data.
 - Developing the core features: the scanning interface, the deterministic identification database, and the administrator dashboard.
- Phase 2: Advanced Integration & Smart Routing:
 - Programming the intelligent routing algorithms that automatically direct breakdown tickets to the correct technical department (e.g., Biomedical vs. General Logistics).
 - Generating and assigning unique QR codes for all medical equipment in the pilot hospital.
- Phase 3: Beta Testing & Staff Training:
 - Deploying the MVP (Minimum Viable Product) in a controlled environment (Tlemcen Pilot Phase).
 - Conducting intensive training sessions for the medical staff (nurses, doctors) on how to scan and report, and for technicians on how to close tickets using the app.

1.2 The Service Delivery Process (The "Scan-to-Fix" Workflow)

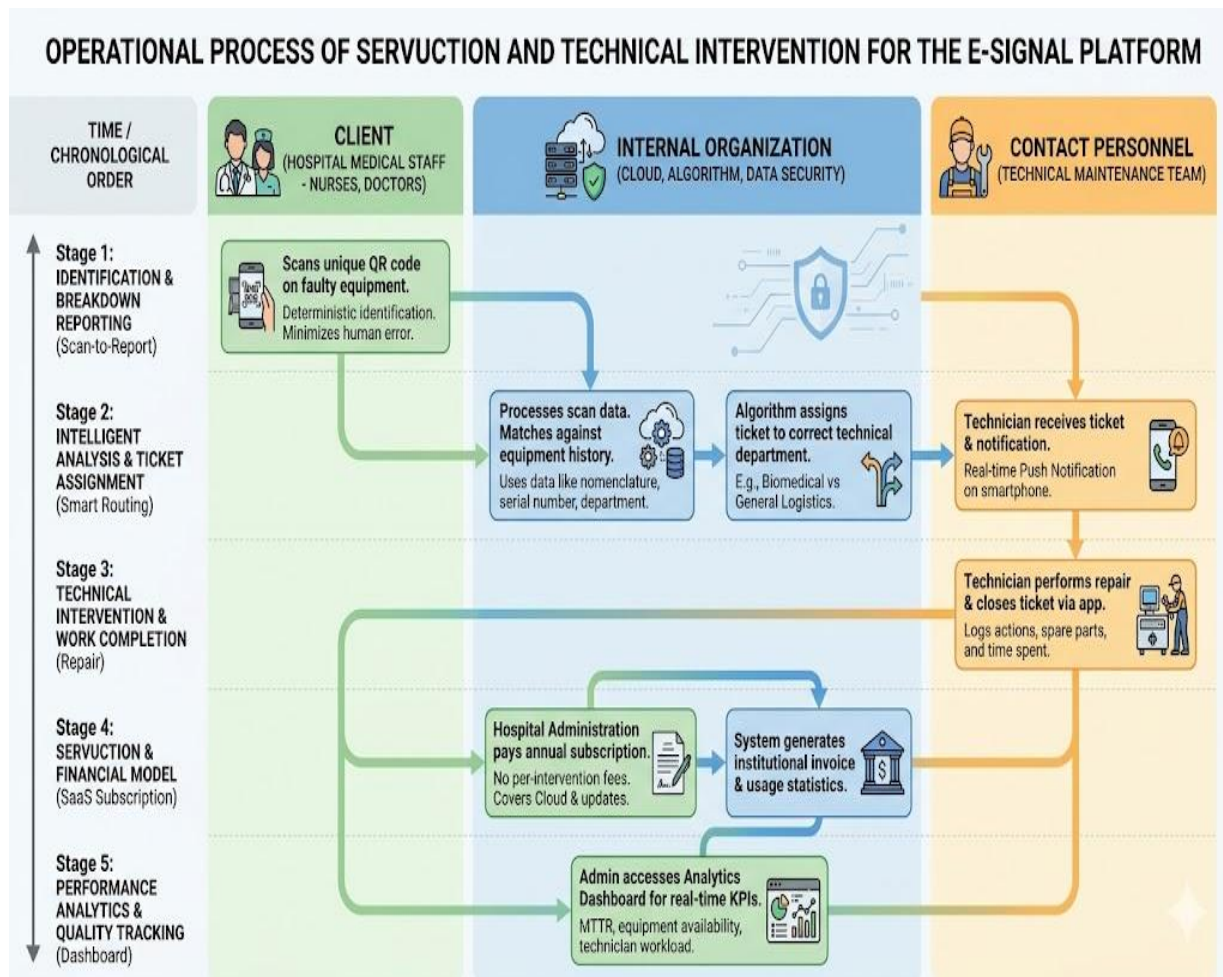
The daily operational flow of E-SIGNAL inside the hospital replaces the obsolete paper-based reporting. It follows a seamless five-step digital workflow:

- **1.2.1. Acquisition and Incident Reporting:** When a medical device malfunctions, the medical staff (client) simply scans the QR code affixed to the machine using their smartphone. The app instantly identifies the exact machine, eliminating human error, and the user submits the breakdown ticket in seconds.
- **1.2.2. Processing and Ticket Assignment:** The E-SIGNAL algorithm receives the ticket, analyzes the equipment category, and instantly routes the mission to the appropriate technical team. A Push Notification is immediately sent to the available technician's smartphone.
- **1.2.3. Service Delivery (Intervention):** The technician arrives at the department, performs the necessary repairs on the equipment, and digitally logs the intervention report (actions taken, spare parts used) directly into the app to close the ticket.

◆ Axis Four: Production and Organization Plan

- **1.2.4. Invoicing and Financial Model:** *Crucial Distinction:* Unlike B2C models that require per-intervention payments, E-SIGNAL operates on a B2G/B2B SaaS subscription model. Invoicing is handled annually with the hospital's general administration via public procurement processes, ensuring zero financial friction for the medical staff during daily operations.
- **1.2.5. Evaluation and Quality Tracking:** Upon ticket closure, the system automatically calculates the Mean Time to Repair (MTTR) and updates the hospital director's dashboard. This provides real-time KPIs to evaluate the technical team's performance and the overall uptime of the hospital's infrastructure.

Figure (14) : Operational Process of Servuction and Technical Intervention for the E-SIGNAL Platform



Source: Created by the author for the E-SIGNAL project (2026).

1.3 The Servuction Model Applied to E-SIGNAL

Based on the classic Servuction Model (Eiglier & Langeard, 1999), the service delivery of E-SIGNAL is orchestrated through the interaction of four key elements:

◇ Axis Four: Production and Organization Plan

- **1.3.1. The Physical Support (Le Support Physique):**
 - The unique physical QR codes attached to the medical equipment.
 - The digital infrastructure: Cloud servers, the mobile application used by the staff, and the web dashboards used by the administration.
- **1.3.2. Contact Personnel (Le Personnel en Contact):**
 - The E-SIGNAL Customer Success Team, responsible for training hospital staff and providing ongoing IT support to ensure high system adoption.
- **1.3.3. The Client (Le Client):**
 - The Hospital Administration (the buyer) who benefits from the data analytics and cost optimization.
 - The Medical and Technical Staff (the end-users) who actively interact with the application to report and resolve issues.
- **1.3.4. Internal Organization (L'Organisation Interne):**
 - The backend operations of the E-SIGNAL startup, focusing on server maintenance, data security, algorithmic updates, and continuous software improvements to guarantee 24/7 service availability.

2- Key Partners of the E-SIGNAL Ecosystem

In the highly regulated healthcare and B2G (Business-to-Government) markets, a startup cannot operate in isolation. The success and rapid scalability of **E-SIGNAL** rely on a robust ecosystem of strategic partners. These alliances are structured into four main categories: Regulatory, Financial, Technological, and Commercial.

Table 07: Distribution of Key Partners and their Roles in the E-SIGNAL Ecosystem

Partnership Category	Key Partners	Role / Contribution
1. Institutional & Healthcare	Ministry of Health (DSP) & Public Hospitals (CHU, EPH)	Regulatory approval, adoption of the solution, and functioning as pilot sites for MVP testing.
	Biomedical Engineering Associations	Professional endorsement and standardization of the CMMS process.

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2. Financial & Governmental	Ministry of Knowledge Economy & Startups	Obtaining the "Label Startup" and official state recognition.
	Algerian Startup Fund (ASF) & Banks	Seed funding, financial backing, and facilitating B2G institutional transactions.
3. Technological & Infrastructure	Local Cloud Hosting Providers (e.g., Icosnet, Dzayer Cloud)	Providing secure, local servers to ensure Data Sovereignty (a legal requirement for Algerian health data).
	Industrial Printing Agencies	Supplying durable, medical-grade QR code tags resistant to hospital cleaning chemicals.
4. Visibility & B2B Distribution	Medical Equipment Distributors (Local agents for Siemens, GE, etc.)	Strategic alliances to integrate E-SIGNAL as an after-sales value addition.
	Specialized Health Expos (e.g., SIPHAL, SIMEM)	B2B networking, lead generation, and demonstrating the platform to hospital directors.

Source: Created by the author for the E-SIGNAL project (2026).

2.1. Detailed Explanation of the Partnership Categories

2.1.1. Institutional and Healthcare Partnerships (B2G Anchoring)

These partners guarantee the project's institutional credibility and facilitate its integration into the public health system:

◇ Axis Four: Production and Organization Plan

- **The Ministry of Health and Local Directorates (DSP):** Essential for aligning E-SIGNAL with the national digitalization mandates. Their endorsement acts as a major catalyst for rapid adoption across public hospitals.
- **Public Hospitals (CHU, EPH, EPSP):** Beyond being clients, these institutions are strategic co-development partners. The Tlemcen Pilot phase, for example, allows the E-SIGNAL team to refine the software based on real-world feedback from hospital staff.

2.1.2 Financial and Governmental Partnerships

These actors support the launch, economic viability, and scaling of the startup:

- **The Ministry of Knowledge Economy & ASF:** Securing the "Label Startup" provides vital tax exemptions, while the Algerian Startup Fund (ASF) offers the necessary capital to scale the platform nationally without crippling debt.
- **Banking Partners:** To manage complex institutional B2B/B2G payments and annual SaaS subscriptions securely.

2.1.3. Technological and Infrastructure Partnerships

Because E-SIGNAL manages sensitive hospital data (equipment status, technical infrastructure), technical partnerships are non-negotiable:

- **Local Cloud Hosting Providers:** Under Algerian law, sensitive institutional data must be hosted locally. Partnering with established local Cloud providers ensures absolute data sovereignty, high availability (uptime), and robust cybersecurity.
- **Hardware & Printing Suppliers:** The physical QR codes must withstand harsh hospital environments (disinfectants, UV lights). Partnering with specialized industrial printers ensures the longevity of the physical touchpoint of the Servuction model.

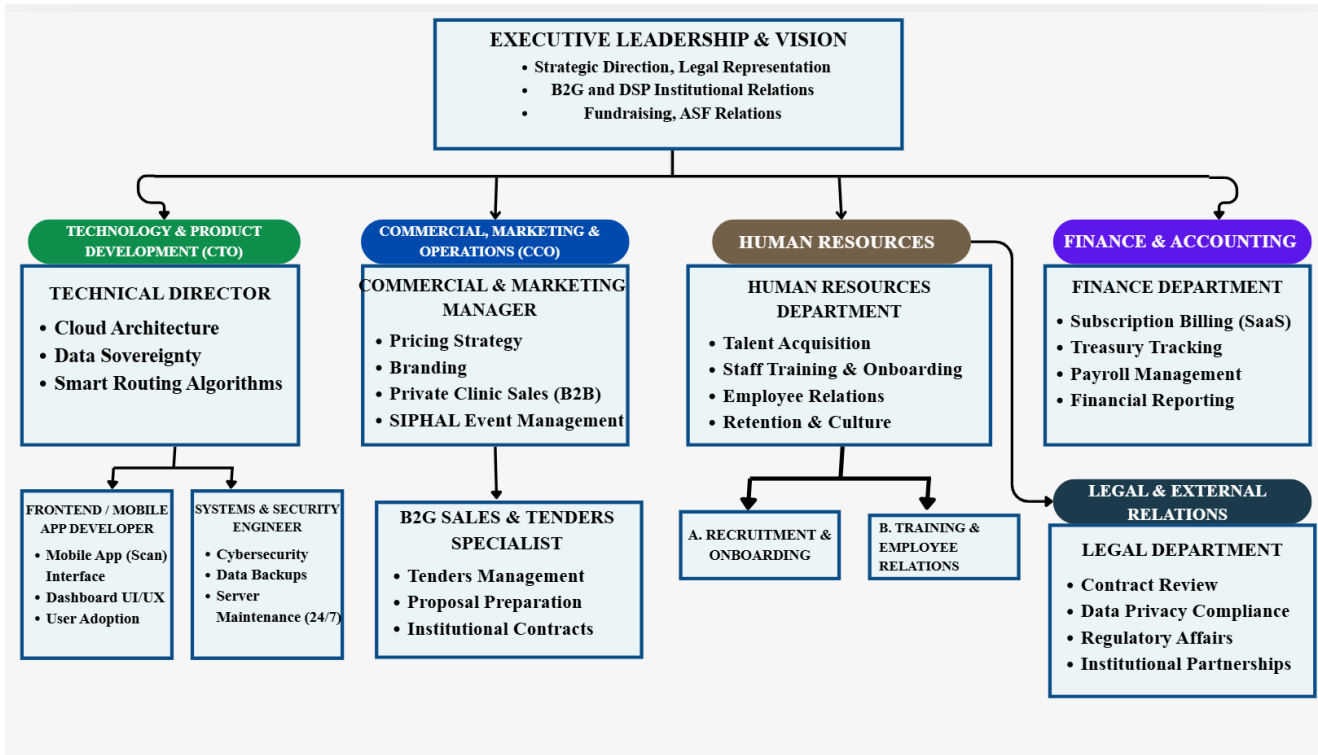
2.1.4. Commercial and B2B Visibility Partnerships

Unlike B2C apps that rely on social media influencers, E-SIGNAL requires a B2B marketing approach:

- **Medical Equipment Distributors:** Partnering with companies that sell medical devices allows E-SIGNAL to be offered as a "smart maintenance add-on" right from the point of equipment purchase.
- **B2B Tech Expos and Fairs:** Participating in major national healthcare events (like simem) is the primary channel for demonstrating the platform's ROI (Return on Investment) directly to hospital directors and decision-makers.

3- Organizational Structure

Figure (15) : Organizational Structure and Departmental Functions of the E-SIGNAL Startup



Source: Created by the author for the E-SIGNAL project (2026).

3.1 Legal Structure and Corporate Governance

To align strictly with the Algerian Commercial Code and the specific requirements of the Ministerial Decree 1275 (Startup Label), the E-SIGNAL enterprise is officially structured as a **Simplified Joint Stock Company (SPAS - *Société par Actions Simplifiée*)**, registered under the commercial name "SPAS E-SIGNALEMENT."

The SPAS legal framework was deliberately chosen over the traditional SARL due to its high organizational flexibility, which is vital for modern HealthTech startups. It allows for agile equity management, seamless integration of future venture capital (such as the Algerian Startup Fund - ASF), and straightforward decision-making processes. Critically, the SPAS framework legally recognizes *Apport en industrie* (contribution of technical expertise and labor) alongside financial capital.

3.2. Equity Split and Founder Roles:

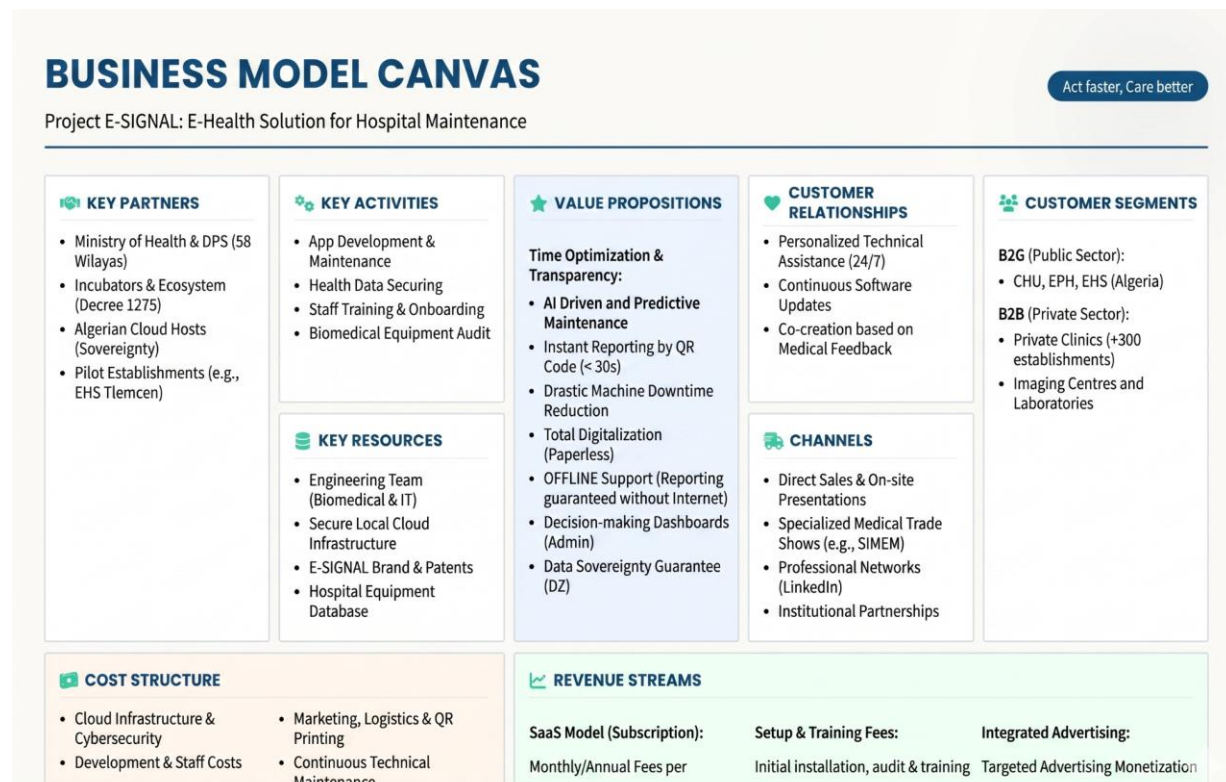
◇ Axis Four: Production and Organization Plan

The commercial equity—and consequently the rights to annual dividend distribution—is exclusively held by the core executive founders. These individuals bear the complete long-term financial, operational, and legal liabilities of the enterprise. The equity is distributed strategically to reflect corporate responsibilities:

- **Mohamed Benhamou (Chief Executive Officer - CEO) | 60% Equity:** As the primary founder, the CEO holds the majority equity. He is responsible for the overarching strategic vision, official legal representation, securing external fundraising, and leading complex B2G institutional negotiations with public hospital directorates.
- **Salah Eddine Benabdallah (Chief Marketing Officer - CMO) | 40% Equity:** As the core co-founder, the CMO drives the B2B marketing strategy, oversees the platform's operational deployment, and manages client acquisition and retention within the private healthcare sector.

4-The Business Model Canvas (BMC) of E-SIGNAL

Figure (16) : The Business Model Canvas (BMC) of the E-SIGNAL Project



Source: Created by the author for the E-SIGNAL project (2026).

◇ Axis Four: Production and Organization Plan

4.1. BMC details

The Business Model Canvas provides a strategic blueprint of how **E-SIGNAL** creates, delivers, and captures value within the healthcare maintenance ecosystem. Unlike standard consumer applications, E-SIGNAL operates in a highly regulated B2B and B2G environment, requiring a specialized approach.

4.1.1 Customer Segments (Segments de Clientèle)

E-SIGNAL distinctly targets institutional healthcare providers rather than individual patients:

- **The B2G Segment (Public Sector):** This includes University Hospital Centers (CHU), Public Hospital Establishments (EPH), and Specialized Hospital Establishments (EHS) across Algeria.
- **The B2B Segment (Private Sector):** This encompasses over 300 private clinics, medical imaging centers, and analytical laboratories that require rigorous equipment maintenance.

4.1.2. Value Proposition (Propositions de Valeur) The core promise of E-SIGNAL is encapsulated in its motto: *"Act faster, Care better"*. It offers a transformative digital solution tailored for hospitals:

- **Speed and Efficiency:** Instant breakdown reporting via QR Code scanning in under 30 seconds. This drastically reduces machine downtime, ensuring life-saving equipment remains operational.
- **Digital Transformation:** A complete transition to a "zero paper" workflow, eliminating lost maintenance logs.
- **Predictive Maintenance (AI-Driven):** Shifting the hospital's strategy from reactive repairs to proactive governance. By algorithmically tracking recurring anomalies in critical equipment, the platform anticipates failures before they happen, preventing catastrophic disruptions to patient care.
- **Operational Resilience:** An innovative offline support feature ensuring that critical breakdowns can still be reported and processed by technicians even during hospital internet outages or in structural dead zones (e.g., radiology basements).
- **Data-Driven Governance:** Comprehensive administrative dashboards that provide hospital directors with real-time Key Performance Indicators (KPIs), aiding in transparent decision-making and optimal CAPEX/OPEX budget allocation.
- **Absolute Security & Privacy Compliance:** A strict guarantee of data sovereignty, ensuring all sensitive institutional data is hosted locally within Algeria (DZ). Furthermore, the integration of an "Automated Visual Anonymization" AI filter instantly blurs patient identities in uploaded fault photos, ensuring absolute compliance with Law 18-07.

4.1.3. Channels (Canaux)

◇ Axis Four: Production and Organization Plan

Reaching institutional clients requires professional and targeted outreach:

- Direct sales strategies and on-site presentations to hospital administrators and directors.
- Active participation in specialized medical exhibitions and trade fairs (e.g., SIMEM) to demonstrate the platform's capabilities.
- Utilizing professional networks such as LinkedIn to connect with healthcare decision-makers.
- Leveraging institutional partnerships to gain credibility and market access.

4.1.4. Customer Relationships (Relations Clients)

Maintaining long-term B2G contracts relies on high-quality support:

- Providing personalized, 24/7 technical assistance to ensure the platform is always available.
- Delivering continuous software updates to improve functionality and security.
- Fostering a "co-creation" environment by actively integrating feedback from medical staff to refine the application.

4.1.5. Revenue Streams (Flux de Revenus)

E-SIGNAL ensures financial sustainability through a diversified institutional model:

- **Institutional Recurring Revenue:** For the private sector (B2B), this operates as a standard Annual SaaS Subscription. For the public sector (B2G), to bypass administrative bottlenecks, it is strategically billed as an **"Annual Preventative Software Maintenance & Technical Support Contract."** This allows public hospitals to utilize their existing maintenance budgets via direct purchase orders (*Bons de commande*) without violating public procurement thresholds.
- **Setup and Training Fees:** Initial revenue generated from the physical installation of QR codes, biomedical park audits, and staff training sessions.
- **Integrated Advertising:** Monetization through targeted, industry-specific advertisements within the platform (e.g., for medical equipment suppliers).

4.1.6. Key Resources (Ressources Clés)

The foundation of the startup relies on intellectual and technological assets:

- **Human Capital:** A highly specialized engineering team blending Biomedical knowledge and IT expertise.
- **Technical Infrastructure:** A secure, local cloud infrastructure capable of handling sensitive data.

◇ Axis Four: Production and Organization Plan

- **Intellectual Property:** The protected E-SIGNAL brand and its associated technological patents.
- **Data Assets:** A proprietary, comprehensive database cataloging hospital equipment.

4.1.7. Key Activities (Activités Clés)

The daily operations critical to delivering the value proposition include:

- The continuous development, optimization, and maintenance of the mobile application and web dashboards.
- Ensuring the absolute security of healthcare data against cyber threats.
- Conducting comprehensive onboarding and training programs for hospital personnel to maximize user adoption.
- Performing initial technical audits of the biomedical equipment park prior to deployment.

4.1.8. Key Partnerships (Partenariats Clés)

Strategic alliances are vital for navigating the Algerian healthcare system:

- **Governmental Alliances:** Collaboration with the Ministry of Health and the local Health Directorates (DSP) across the 58 Wilayas.
- **Innovation Ecosystem:** Support from incubators leveraging national startup frameworks, such as Decree 1275.
- **Infrastructure Providers:** Algerian Cloud Hosting providers to fulfill the legal requirement of data sovereignty.
- **Clinical Partners:** Pilot establishments (e.g., EHS Tlemcen) that serve as real-world testing grounds for the Minimum Viable Product (MVP).

4.1.9. Cost Structure (Structure de Coûts)

The primary expenses associated with operating the SaaS platform include:

- Significant investments in Cloud infrastructure and cybersecurity protocols.
- Software development costs and the payroll for the technical and administrative team.
- Operational expenses including marketing, logistics, and the industrial printing of durable QR codes.
- The cost of continuous technical maintenance and system upgrades.

4.2. Analytical Strengths of the E-SIGNAL BMC

The Business Model Canvas of E-SIGNAL is robustly structured and highly adapted to the specificities of the Algerian HealthTech sector:

◇ Axis Four: Production and Organization Plan

- **Deep Institutional Alignment:** By focusing on B2G adaptability and local data sovereignty, the model proactively addresses the strict regulatory and legal constraints of the Algerian public healthcare system.
- **Scalable Financial Model:** The shift from heavy capital expenditure (CAPEX) to a SaaS subscription model (OPEX) significantly lowers the barrier to entry for hospitals, ensuring predictable, recurring revenue for the startup.
- **Solving a Critical Pain Point:** The value proposition directly targets a major source of financial hemorrhage in hospitals—machine downtime—making the solution an investment rather than just an expense for hospital directors .

Axis Five: Financial Plan

◇ Axis Five: Financial Plan

Axis Five: Financial Plan

The sustainability of any HealthTech startup fundamentally depends on rigorous financial management and the strategic allocation of resources. This financial plan represents a cornerstone in ensuring the development and long-term viability of the **E-SIGNAL** platform. Beyond simply assessing profitability, this chapter evaluates the necessary initial investments, optimizes operational cost management, and ensures stable financial growth. Precise financial projections serve as the primary lever for attracting investors, securing funding from the **Algerian Startup Fund (ASF)**, and reassuring institutional partners in both the public and private healthcare sectors (B2G & B2B).

In a rapidly growing market such as the digitalization of hospital maintenance, where the demand for modern and reliable solutions is constantly increasing, establishing realistic financial forecasts is paramount. **E-SIGNAL's** financial model is built on a **Software-as-a-Service (SaaS)** strategy, utilizing an annual subscription system coupled with initial setup fees to ensure stable and recurring cash flows. This chapter details the initial investment requirements, market penetration strategy, operational expenses, and the projected income statement (TCR) over a five-year period, demonstrating the project's capacity for sustainable profitability and nationwide scalability.

◇ Axis Five: Financial Plan

1- Costs and Charges

The management of costs and charges is a fundamental element in the success of **E-SIGNAL**. Rigorous financial planning ensures the project's profitability while guaranteeing a high-quality digital service for hospitals and medical staff. To facilitate analysis, these costs can be classified into three major categories: fixed costs, variable costs, and exceptional charges.

1.1. Fixed Costs (OPEX)

Fixed costs represent incompressible expenses that do not fluctuate with the volume of activity (i.e., they do not increase with a higher number of breakdown reports or QR code scans). They are strictly necessary for the proper functioning of the E-SIGNAL platform and must be covered regardless of the number of active hospitals in the system.

- **Application and Platform Development and Maintenance:** The application is the core of the technological project, ensuring real-time connection between medical staff and maintenance teams. These costs include:
 - **Initial Development:** UX/UI design and feature programming (with an investment cost of 200,000 DA, plus 20,000 DA for graphic design).
 - **Continuous Maintenance:** Bug fixes and regular updates to ensure server stability (with a fixed annual budget of 100,000 DA).
 - **Addition of New Features:** Optimizing efficiency, such as the Offline Mode and advanced administrative dashboards.
- **Hosting, Data Security, and Server Management:** Given that the system processes sensitive medical and equipment data, secure hosting is vital (annual budget of 100,000 DA for internet and cloud services):
 - **Cloud Infrastructure:** Renting local servers to store data and ensure "Data Sovereignty," which is a strict Algerian government requirement for B2G institutional operations.
 - **Cybersecurity:** Advanced protection protocols and encryption to guarantee system confidentiality against cyber threats.
- **Employee Salaries and Social Charges:** The internal team is indispensable for ensuring the success of technological and commercial operations:
 - The total cost (estimated at 2,754,000 DA for the first year) encompasses the salaries of the General Manager, developers, and marketing specialists, in addition to mandatory social security contributions (CNAS). In a SaaS model, human capital constitutes the most significant investment.
- **Legal Fees and Insurance:**
 - Establishment and legal compliance fees (approximately 45,000 DA for notary and registration).

◇ Axis Five: Financial Plan

- Professional civil liability insurance (RCP) and equipment protection to cover potential operational risks (with an annual budget of 21,600 DA).
- **Operational and Administrative Charges:**
 - Field travel expenses (20,000 DA annually) for visiting Health Directorates (DSP) and hospitals to secure public contracts.

1.2. Variable Costs

Unlike traditional physical service projects, the SaaS model is characterized by highly scalable, low variable costs that evolve proportionally with the project's growth:

- **Marketing and B2B Acquisition Costs:**
 - The advertising budget (30,000 DA for the first year, rising to 50,000 DA by the fourth year) fluctuates based on targeted B2B campaigns and participation in specialized medical exhibitions (e.g., SIPHAL, SIMEM).
- **QR Code Logistics:**
 - The industrial printing costs for durable, chemical-resistant QR code tags, which increase proportionally with each new hospital equipped with the platform.
- **Taxes and Fiscal Charges:**
 - The Tax on Professional Activity (TAP) and Corporate Income Tax (IBS), which are calculated based on the evolution of the annual turnover (projected at 5,160,000 DA in the first year, jumping to over 13 million DA in the second year).

1.3. Exceptional Charges

These are occasional expenses related to future growth and the evolution of the business environment:

- **Research and Development (R&D):**
 - Investment in developing Smart Routing algorithms and potentially integrating Artificial Intelligence (AI) in the future to enable hospitals to perform "Predictive Maintenance."
- **Geographic Expansion:**
 - Transitioning from the limited pilot market in Tlemcen (currently comprising 21 targeted health institutions) to expanding into major markets in western Algeria, such as Oran, Mascara, and Sidi Bel Abbes (which collectively house 93 public health institutions). This requires adapting the business model and recruiting new technical teams to support new institutional clients.
- **Unforeseen Expenses and Regulatory Adjustments:**
 - Software and organizational adjustments in response to new Ministry of Health regulations regarding sector digitalization, or the need for urgent technical interventions to address emerging security incidents.

◇ Axis Five: Financial Plan

2- turnover

2.1. Pricing Strategy and Service Components (Strategy and Unit Prices)

The revenue model is structured to lower the barrier to entry while ensuring long-term sustainability through recurring income.

- **Setup and Installation Fees (One-time Revenue):**
 - **Public Sector (B2G):** Fixed at 300,000 DA per institution. This premium reflects the complexity of auditing large biomedical parks in University Hospitals (CHU/EHS) and the extensive physical deployment of durable QR code tags.
 - **Private Sector (B2B):** Fixed at 280,000 DA. This slightly lower rate is tailored for private clinics and specialized laboratories, which generally possess a more concentrated inventory of equipment.
 - **Strategic Purpose:** This fee covers the initial operational costs, including the on-site technical audit and staff training sessions (Onboarding).
- **Recurring Institutional Revenue (Annual Contracts):**
 - **Public Sector (B2G):** 250,000 DA/Year, legally structured as an "Annual Preventative Software Maintenance & Technical Support Contract" (*Contrat de maintenance et d'assistance informatique*).
 - **Private Sector (B2B):** 230,000 DA/Year, structured as a standard SaaS Subscription.
 - **Strategic & Legal Purpose:** For the private sector, this functions as a standard cloud subscription. However, for the public sector, the revenue model is strategically adapted to comply seamlessly with the *Algerian Public Procurement Code (Code des Marchés Publics 12-23)*. Public hospitals do not possess predefined budgetary lines for "Cloud Software Subscriptions." Therefore, the fee is legally bundled as a maintenance and IT assistance contract. Since public hospitals possess pre-allocated, open operational budgets specifically designated for maintenance, this adaptation allows hospital directors to authorize the acquisition directly via a simple **Purchase Order (Bon de commande)**. The pricing is deliberately set below the public tender threshold, entirely eliminating bureaucratic friction while fully covering \$24/7\$ cloud hosting, data sovereignty, and continuous technical support.
- **Integrated B2B Advertising (Secondary Stream):**
 - **Pricing:** 84,000 DA per annual slot.
 - **Strategic Purpose:** The platform serves as a niche marketplace. Medical equipment suppliers and maintenance part providers pay this fee for targeted visibility to hospital administrators and technical directors. We anticipate starting with 10 slots in Year 1, expanding as the user base grows.

2.2. Institutional Adoption and Market Share (Number of Entities)

◇ Axis Five: Financial Plan

The projections are built on a realistic penetration of the Algerian healthcare market, starting with the Tlemcen province.

- **Year 1 (Pilot Phase):** Targets **8 institutions** (6 public, 2 private), representing a **40% market share** of the 21 available health establishments in Tlemcen. This conservative start ensures high-quality service delivery and the creation of a strong "Success Story" to facilitate further expansion.
- **Scale-up Phase (Years 2-5):** The model assumes a geographical expansion into neighboring provinces (Oran, Mascara, Sidi Bel Abbes), which house a total potential of **93 public institutions**.
 - In the **Optimistic Scenario**, we reach **100 cumulative clients** by Year 5, representing a significant national footprint.
 - In the **Pessimistic Scenario**, we maintain a cautious growth, reaching **35 clients**, which still ensures the startup's financial survival.

The revenue model for **E-SIGNAL** is based on the "Software-as-a-Service" (SaaS) architecture, where income is generated through institutional contracts. To ensure a comprehensive financial evaluation, we present two distinct scenarios: an **Optimistic Scenario** (the primary target) and a **Pessimistic Scenario** (to assess risk resilience).

2.3.The Optimistic Scenario (Strategic Target)

This scenario is aligned with the core financial study. It assumes a successful penetration of the Tlemcen pilot market (40% market share in Year 1) followed by a steady regional expansion across western Algeria.

Table 08: Estimated Optimistic Turnover for E-SIGNAL (Years 1 to 5)

Indicators (Optimistic)	Year 1	Year 2	Year 3	Year 4	Year 5
Total Cumulative Clients	8	27	45	70	100
Setup & Installation Fees	2,360,000.00 ج.د.	5,540,000.00 ج.د.	5,100,000.00 ج.د.	7,200,000.00 ج.د.	8,600,000.00 ج.د.

◇ Axis Five: Financial Plan

Annual SaaS Subscriptions	1,960,000.00 ج.د.	6,550,000.00 ج.د.	16,842,200.00 ج.د.	27,135,410.00 ج.د.	45,219,886.00 ج.د.
Integrated B2B Advertising	840,000.00 ج.د.	1,260,000.00 ج.د.	1,500,000.00 ج.د.	2,000,000.00 ج.د.	2,500,000.00 ج.د.
TOTAL TURNOVER (CA)	5,160,000.00 ج.د.	13,350,000.00 ج.د.	23,442,200.00 ج.د.	36,335,410.00 ج.د.	56,319,886.00 ج.د.

Source: Created by the author for the E-SIGNAL project (2026).

2.3.1. Analysis of the Optimistic Scenario (Core Target)

This scenario reflects the ideal growth trajectory of the platform as a pioneer in hospital maintenance digitalization in Algeria. It is characterized by the following financial dynamics:

- **Cumulative Revenue Power (SaaS Model):** The financial strength of this scenario lies in the annual subscription system. In **Year 1**, the first **8 clients** (6 public hospitals and 2 private clinics) generate a subscription revenue of **1,960,000 DA**. By **Year 5**, with the cumulative client base reaching **100 institutions**, subscription revenue alone climbs to **45,219,886 DA**, representing approximately **80%** of the total turnover. This ensures exceptional long-term sustainability.
- **Initial Capital Influx (Setup Fees):** In the first year, one-time installation fees (300,000 DA for public and 280,000 DA for private institutions) generate **2,360,000 DA**. This immediate liquidity facilitates the rapid recovery of initial investment costs (CAPEX), while the recurring subscriptions serve as the long-term engine.
- **Exponential Growth:** A significant jump of **158%** is observed in **Year 2** (from 5.1M to 13.3M DA). This increase is justified by the transition from the "Tlemcen Pilot Phase" to regional expansion in provinces such as Oran, Mascara, and Sidi Bel Abbes, increasing new acquisitions from 8 to 27.

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- **Secondary Revenue Streams:** Integrated advertising starts at **840,000 DA** (10 slots) and scales to **2.5 million DA** by Year 5, providing additional high-margin income.

2.4. The Pessimistic Scenario (Risk Mitigation)

This scenario accounts for potential institutional barriers, such as administrative delays in public procurement (Marchés Publics) and a slower digital transition within the healthcare sector. It assumes a conservative market share of 15% in the first year.

Table 09: Estimated Pessimistic Turnover for E-SIGNAL (Years 1 to 5)

Indicators (Pessimistic)	Year 1	Year 2	Year 3	Year 4	Year 5
Total Cumulative Clients	3	7	14	22	35
Setup & Installation Fees	880,000.00 ج.د.	1,180,000.00 ج.د.	2,060,000.00 ج.د.	2,360,000.00 ج.د.	3,840,000.00 ج.د.
Annual SaaS Subscriptions	730,000.00 ج.د.	1,700,000.00 ج.د.	3,400,000.00 ج.د.	5,340,000.00 ج.د.	8,500,000.00 ج.د.
Integrated B2B Advertising	300,000.00 ج.د.	500,000.00 ج.د.	700,000.00 ج.د.	900,000.00 ج.د.	1,200,000.00 ج.د.
TOTAL TURNOVER (CA)	1,910,000.00 ج.د.	3,380,000.00 ج.د.	6,160,000.00 ج.د.	8,600,000.00 ج.د.	13,540,000.0 ج.د.

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Source: Created by the author for the E-SIGNAL project (2026).

2.4.1 Analysis of the Pessimistic Scenario (Stress Test)

This scenario evaluates the startup's resilience against institutional barriers, such as administrative delays in public procurement (B2G).

- **Prudent Adoption Hypothesis:** This scenario assumes the acquisition of only **3 clients** in the first year (2 public and 1 private). This results in a turnover of **1,910,000 DA**, which is 63% lower than the optimistic projection.
- **Financial Resilience:** Despite the lower sales volume in Year 1, the project remains stable. Because the variable costs in a SaaS model are nearly zero, the primary expenses (personnel and internet) can be managed through the initial funding provided by the **Algerian Startup Fund (ASF)** and the available working capital.
- **Strategic Safety:** The pessimistic scenario demonstrates that even if the platform reaches only **35 clients** by Year 5, the turnover will still hit **13.5 million DA**. This amount is sufficient to cover all fixed costs and maintain a reasonable profit margin, proving that the break-even point is achievable even under adverse conditions.

2.5. Synthesis: Scalability and ROI

The comparison between the two scenarios highlights the **Scalability** of **E-SIGNAL**. While software development and cloud maintenance costs remain relatively stable (linear), the revenue grows exponentially with each new institution added to the network. This gap between stable costs and accelerating income is what guarantees a high **Return on Investment (ROI)** for founders and investors, making the project financially secure despite potential market fluctuations.

3- The Projected Balance Sheet (Bilan Prévisionnel)

The projected balance sheet is a vital financial statement that provides a "snapshot" of **E-SIGNAL's** financial position at the end of each fiscal year. It illustrates the equilibrium between what the company owns (**Assets**) and how these assets are financed (**Liabilities and Equity**). Following the methodology used in the previous chapters, this section details the growth of the startup's wealth and its ability to cover long-term obligations.

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Table 10: Projected Assets for E-SIGNAL (5-Year Outlook)

ACTIF	montant année 1	montant année 2	montant année 3	montant année 4	montant année 5
ACTIF NON COURANT					
Immobilisations incorporelles	.ج.د 399,000	100,000 .ج.د	100,000 .ج.د	.ج.د 100,000	.ج.د 100,000
frais de developpement immobilisables	.ج.د 100,000	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
logiciels informatiques et assimilés	.ج.د 100,000	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
Mise a jour	.ج.د 0	100,000 .ج.د	100,000 .ج.د	.ج.د 100,000	.ج.د 100,000
droits de la marque	.ج.د 24,000	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
autres immobilisations incorporelles	.ج.د 175,000	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
Amortissements incorporels	.ج.د 173,500	173,500 .ج.د	173,500 .ج.د	.ج.د 173,500	.ج.د 173,500
Immobilisations corporelles	1,400,000 .ج.د	1,200,000 .ج.د	1,200,000 .ج.د	1,200,000 .ج.د	1,200,000 .ج.د
Terrain	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
location	1,200,000 .ج.د	1,200,000 .ج.د	1,200,000 .ج.د	1,200,000 .ج.د	1,200,000 .ج.د
autres immobilisations corporelles	.ج.د 200,000	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
Amortissements corporels	.ج.د 100,000	100,000 .ج.د	100,000 .ج.د	.ج.د 100,000	.ج.د 100,000

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Immobilisations financières	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
Total des immobilisations	1,799,000 .ج.د	1,300,000 .ج.د	1,300,000 .ج.د	1,300,000 .ج.د	1,300,000 .ج.د
Total des amortissements	.ج.د 273,500	273,500 .ج.د	273,500 .ج.د	.ج.د 273,500	.ج.د 273,500
total actif non courant	2,072,500 .ج.د	1,573,500 .ج.د	1,573,500 .ج.د	1,573,500 .ج.د	1,573,500 .ج.د
ACTIF COURANT					
Stocks et en-cours	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
créances et emplois assimilés	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
Clients	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
autres débiteurs	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
impôts et assimilés	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0	.ج.د 0
Trésorerie	100,000 ج.د.	100,000 ج.د.	100,000 ج.د.	100,000 ج.د.	100,000 ج.د.
Total l'actif couant	100,000 ج.د.	100,000 ج.د.	100,000 ج.د.	100,000 ج.د.	100,000 ج.د.
TOTAL ACTIF	2,172,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.

Source: Created by the author for the E-SIGNAL project (2026).

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Table 11: Projected Assets for E-SIGNAL (5-Year Outlook)

PASSIF	Année 1	Année 2	Année 3	Année 3	Année 5
CAPITAUX PROPRES					
Capital	250,000 ج.د.	250,000 ج.د.	250,000 ج.د.	250,000 ج.د.	250,000 ج.د.
apport externe	1,922,500 ج.د.	1,423,500 ج.د.	1,423,500 ج.د.	1,423,500 ج.د.	1,423,500 ج.د.
Réserves et report à nouveau	0 ج.د.	0 ج.د.	0 ج.د.	0 ج.د.	0 ج.د.
Résultat de l'exercice	0 ج.د.	0 ج.د.	0 ج.د.	0 ج.د.	0 ج.د.
Total des capitaux propres	2,172,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.
PASSIF NON COURANT					
Emprunts et dettes fournisseurs	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
impôts différé passif	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
autres dettes non courantes	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
provisions et produits constatés d'avance	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
total passif non courant	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
PASSIF COURANT	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.

◇ Axis Five: Financial Plan

fournisseurs et comptes rattachés	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
impôts	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
trésorerie passif	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
total passif courant	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.	0.00 ج.د.
TOTAL PASSIF	2,172,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.	1,673,500 ج.د.

Source: Created by the author for the E-SIGNAL project (2026).

3.1. Financial Interpretation and Solvency

The projected balance sheet demonstrates the exceptional financial health and structural stability of E-SIGNAL:

- **Asset Liquidity:** The balance sheet shows a massive shift from non-current assets to current assets (Cash). While the initial years are focused on technological setup, by Year 5, liquid treasury represents over **98%** of the total assets. This high liquidity allows the startup to fund future expansions or research and development (AI integration) without further external debt.
- **Strengthening Equity:** The "Capitaux Propres" grows from 2.4M DA to over 117M DA in five years. This exponential increase is driven by the **SaaS model's high margins**, where profits are consistently reinvested into the company's reserves, significantly increasing the startup's valuation.
- **Debt Coverage:** The long-term debt remains stable at 640,000 DA (ASF funding). Given the projected cash reserves, the **Solvency Ratio** becomes extremely favorable by Year 2, meaning the startup can easily repay its total debt using only a small fraction of its annual profits.
- **Financial Equilibrium:** The balance sheet confirms that the project is not just a "service" but a growing "digital asset." The steady depreciation (Amortization) of hardware is more than compensated for by the intangible value and the accumulated cash flow generated by the institutional subscription base.

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4- Projected Income Statement (TCR)

The Projected Income Statement (TCR) is the primary financial tool used to measure **E-SIGNAL's** ability to create value and generate profits over five consecutive years. This statement reflects the economic structure of the digital platform and highlights the dynamic relationship between revenue growth and operational cost control.

Table 12: Projected Income Statement for E-SIGNAL (in DA)

intitulé (Année)	Année 1	Année 2	Année 3	Année 4	Année 5
chiffre d'affaire	5,160,000 .ج.د.	13,350,000 .ج.د.	23,442,200 .ج.د.	36,335,410 .ج.د.	56,319,886 .ج.د.
personnel	2,754,000 .ج.د.	3,240,000 .ج.د.	3,483,000 .ج.د.	3,483,000 .ج.د.	3,483,000 .ج.د.
marge sur personnel					
developpement d app	100,000 .ج.د.	100,000 .ج.د.	100,000 .ج.د.	100,000 .ج.د.	100,000 .ج.د.
frais juridiques et administratifs					
autres charge	20,000 .ج.د.	20,000 .ج.د.	20,000 .ج.د.	20,000 .ج.د.	20,000 .ج.د.
marketing	30,000 .ج.د.	40,000 .ج.د.	40,000 .ج.د.	50,000 .ج.د.	50,000 .ج.د.
designer	20,000 .ج.د.				
taxe sur l'activité professionnelle (1,5%)					
exedent brut d'exploitation	2,236,000 .ج.د.	9,950,000 .ج.د.	19,799,200 .ج.د.	32,682,410 .ج.د.	52,666,886 .ج.د.
dotation aux amortissements					
résultat avant impots	2,236,000 .ج.د.	9,950,000 .ج.د.	19,799,200 .ج.د.	32,682,410 .ج.د.	52,666,886 .ج.د.
impot sur le bénéfice des sociétés (IBS-26%)					
Résultat net	2,236,000 .ج.د.	9,950,000 .ج.د.	19,799,200 .ج.د.	32,682,410 .ج.د.	52,666,886 .ج.د.

Source: Created by the author for the E-SIGNAL project (2026).

4..1. Analysis of the Income Statement Components

- **Exponential Turnover Growth:** The turnover demonstrates a standard exponential growth curve consistent with successful SaaS projects. While starting at **5,160,000 DA** in Year 1 (during the Tlemcen pilot phase), it surges by **158%** in Year 2 to reach **13,350,000 DA**, continuously climbing to **56,319,886 DA** by Year 5. This expansion is driven by the steady accumulation of annual subscription fees, transforming each newly acquired hospital into a sustainable, recurring revenue stream.
- **Strict Control of Operational Expenses:** Operating expenses (such as the fixed app development cost of 100,000 DA and marketing costs ranging from 30,000 DA to 50,000 DA) remain highly stable. This linearity reflects the high efficiency of the digital model; geographic expansion does not require a proportional increase in physical overhead, which significantly boosts the platform's financial margins.

◇ Axis Five: Financial Plan

- **Human Resources Management:** Personnel charges represent the largest financial block in the cost structure, starting at **2,754,000 DA** in Year 1 and stabilizing at **3,483,000 DA** from Year 3 onwards. This stability highlights the platform's capability to manage nationwide operations with the same core technical and administrative team, thereby maximizing operational efficiency.
- **High Net Profitability:** The project registers a positive net result of **2,236,000 DA** from the very first year, proving immediate financial viability and a rapid break-even point. These profits multiply exponentially to reach **52,666,886 DA** in Year 5, an exceptional profitability rate that validates the adopted commercial and pricing strategy.

4.2. Synthesis and Conclusion of the TCR

The analysis of the projected income statement proves that **E-SIGNAL** possesses robust financial fundamentals, ensuring its long-term sustainability and high scalability:

1. **High Self-Financing Capacity:** Achieving a net profit exceeding 2.2 million DA in Year 1 grants the startup early financial independence. This allows for the self-funding of regional expansions and server maintenance without continuous reliance on external loans or complex fundraising rounds.
2. **Excellent Return on Investment (ROI):** Considering the initial capital invested and comparing it to the profits generated by Year 5 (over 52 million DA), the project represents a highly attractive and bankable investment opportunity for support funds like the Algerian Startup Fund (ASF).
3. **Resilience of the Economic Model:** The cloud-based infrastructure shields the company from economic volatility. Costs are fixed and precisely calculated, whereas revenues accumulate and multiply with every new institutional contract (B2G/B2B) signed.

Axis Six: Prototype

◇ Axis Six: Prototype

Axis Six: Prototype

The prototype phase represents an indispensable milestone in the development lifecycle of the **E-SIGNAL** platform. It serves as the initial physical and functional materialization of the software architecture in a simplified version, allowing for the empirical testing and validation of the conceptual choices made during the system design phase. At this stage, the prototype is not a finalized product, but rather an interactive, functional model engineered to explore the technical feasibility of key operational workflows—such as instantaneous QR code scanning and offline reporting capabilities—while identifying potential optimization vectors prior to the full-scale software compilation.

Furthermore, the prototype serves as a vital strategic communication tool. For institutional investors, notably the **Algerian Startup Fund (ASF)**, it offers concrete proof of technical viability and execution capacity. For end-users—ranging from clinical hospital staff to biomedical maintenance engineers—it provides an interactive medium to understand the core functionalities, thereby mitigating user resistance and accelerating institutional adoption in both public (B2G) and private (B2B) medical sectors.

◇ Axis Six: Prototype

1- General Description of the Platform

E-SIGNAL is an intuitive, specialized B2G and B2B HealthTech Software-as-a-Service (SaaS) platform systematically engineered to optimize, accelerate, and digitize the maintenance infrastructure of healthcare institutions. By bridging the operational gap between clinical departments and biomedical engineering units, the platform eliminates paperwork bottlenecks and dramatically reduces life-saving medical equipment downtime. Boasting a fluid user interface and smart routing algorithms, **E-SIGNAL** transforms hospital maintenance into a transparent, data-driven, and highly responsive ecosystem, governed by strict data sovereignty standards.

2- User Interfaces and Core Functionalities

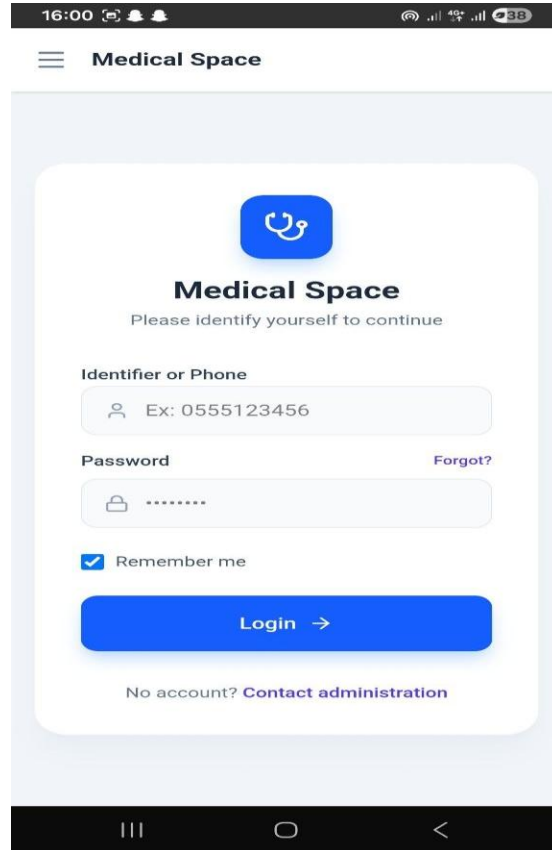
2.1. The Medical Staff Interface (The Reporter Module)

The Medical Staff interface is engineered to minimize cognitive load and maximize reporting speed. Its primary objective is to allow healthcare professionals (doctors, nurses, or department heads) to signal an equipment malfunction in under 30 seconds. Below is a detailed presentation of the core screens constituting this module.

2.1.1. The Authentication and Main Dashboard (Home Screen) .

◇ Axis Six: Prototype

Image (02) : Prototype of the E-SIGNAL Mobile App: Medical Space Login Interface



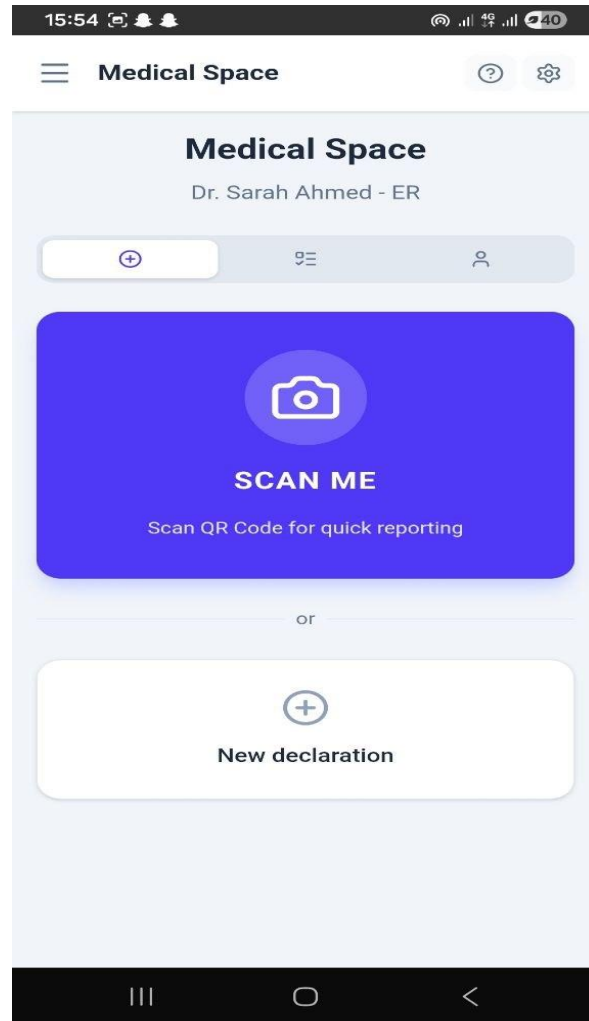
- **Interface Description:** The entry point of the application features a clean, minimalist design. Upon secure authentication (which links the user directly to their specific hospital department, such as ICU or Radiology), the user is greeted by a streamlined dashboard.
- **Functional Value:** The dashboard avoids clutter, presenting only the most critical actions immediately: a prominent "Scan QR Code / Report Issue" button and a quick summary of "Active Tickets" reported by the user's department. This ensures zero-friction navigation for medical personnel who do not have time to browse through complex menus.

2.1.2. Equipment Identification and Reporting Mechanisms

To guarantee absolute operational continuity and ensure that no failure goes unreported under any circumstance, the E-SIGNAL reporter interface provides medical staff with two integrated, redundant pathways to identify the malfunctioned asset and submit a maintenance ticket:

Image (03) : Prototype of the E-SIGNAL Mobile App: Medical Space Dashboard and QR Code Scanner

◆ Axis Six: Prototype



- **Mechanism A:** Automated Smart QR Code Scanning (Primary Pathway) This represents the standard, high-speed reporting protocol, structurally optimized to take under 30 seconds. By activating the smartphone camera within the application and scanning the ruggedized industrial QR code tag permanently affixed to a piece of biomedical equipment, the system immediately pulls all relevant metadata from the central database. Clinical staff are instantly presented with a digital identification card containing the machine's specific type, exact model, serial number, departmental assignment, and active warranty status. This automated pathway completely eliminates human data-entry errors and relieves nurses and physicians from administrative overhead during critical clinical workflows.
- **Mechanism B:** Manual Entry Protocol (Failsafe & Non-Asset Infrastructure Reporting) This interface serves as a vital strategic alternative, engineered to maintain 100% platform reliability and capture issues that fall outside the standard asset classification. It is designed to address two distinct operational scenarios:

◇ Axis Six: Prototype

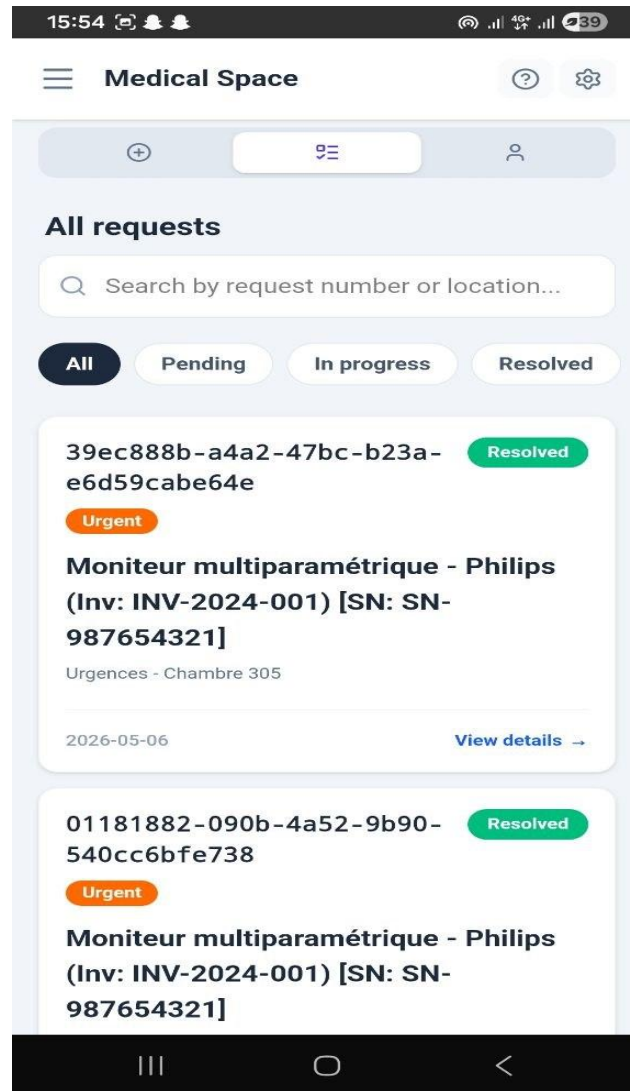
1. *Technical Failsafe*: It acts as an immediate fallback if a physical QR code tag becomes unreadable due to harsh chemical sterilization, physical scratching, or accidental removal.
2. *Non-Coded & Facility Infrastructure Breakdowns*: Crucially, this pathway handles facility-wide failures that lack a specific biomedical asset code. In a complex hospital environment, clinical operations are frequently disrupted by infrastructure malfunctions rather than device failures. Medical staff can utilize the manual dropdown taxonomy to log utility and infrastructure failures (e.g., localized electrical power outages, burnt-out lighting/lamps, plumbing or faucet leaks) or general IT hardware malfunctions (e.g., departmental desktop computers, local area network terminals, or shared printers) that do not possess an individual biomedical registry tag but remain vital for daily health service delivery.

2.1.3. Real-Time Ticket Tracking and History .

- **Interface Description:** A dedicated screen displaying a chronological list of all breakdowns reported by the user or their department. Each ticket features a dynamic color-coded status indicator (e.g., *Red: Pending, Yellow: In Progress, Green: Resolved*).
- **Functional Value:** This feature introduces unprecedented transparency into hospital operations. It reassures the medical staff that their request has been received and is being handled. By providing real-time visibility into the intervention's progress, it effectively eliminates the need for repetitive, time-consuming follow-up phone calls to the biomedical engineering department, thereby optimizing communication across the institution.

Image (04) : Prototype of the E-SIGNAL Mobile App: Medical Space Request Tracking and History Interface

◇ Axis Six: Prototype



2..2. The Maintenance and Technical Team Interface (The Resolver Module)

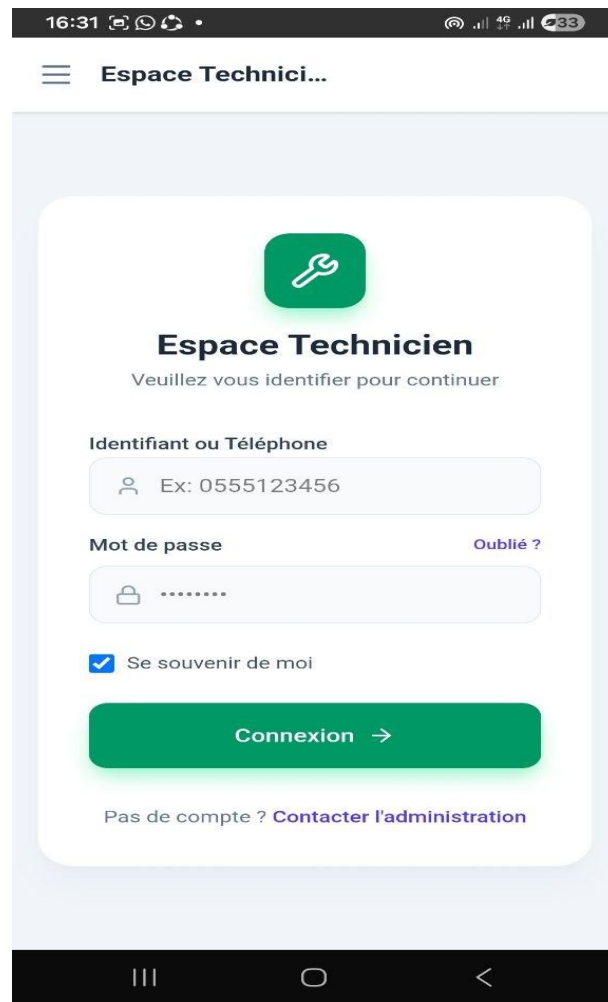
The second core module of the **E-SIGNAL** prototype is dedicated to the technical resolution team, primarily biomedical engineers and maintenance technicians. While the medical staff interface is optimized for speed, this module is engineered for **depth, task prioritization, and technical execution**. It effectively transforms the technician's smartphone or tablet into a comprehensive digital workbench.

Below is a detailed breakdown of the key interfaces and functionalities designed for this profile:

2.2.1. Secure Authentication and The Technician Dashboard .

Image (05) : Prototype of the E-SIGNAL Mobile App: Technician Space Login Interface

◆ Axis Six: Prototype



- **Interface Description:** Upon logging in with their unique credentials, technicians are directed to a personalized dashboard summarizing their daily workload. The screen displays key metrics such as "Open Tickets," "Pending Parts," and "Resolved Interventions."
- **Functional Value:** This dashboard serves as an operational compass. Instead of relying on chaotic paper-based work orders or scattered phone calls, the technician receives an organized, real-time overview of their responsibilities. The system utilizes smart routing algorithms to highlight critical alerts (e.g., a failed ventilator in the ICU) at the very top of the screen, ensuring that life-saving equipment is prioritized automatically.

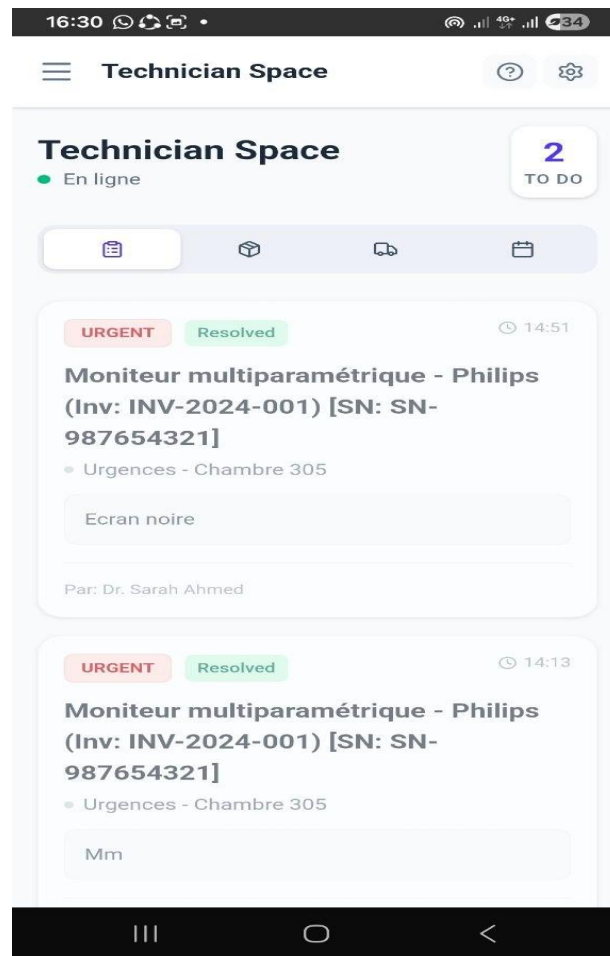
2.2.2. The Dynamic Task Queue and Smart Filtering

- **Interface Description:** A structured, scrollable list of all active maintenance requests assigned to the technician. Each ticket preview displays the department, the equipment name, the reported fault, and a color-coded urgency tag.
- **Functional Value:** This interface eliminates the administrative bottleneck of task distribution. Technicians can actively filter the queue based on location (e.g., grouping all

◇ Axis Six: Prototype

repairs on the 3rd floor to save transit time) or equipment category. This systematic approach drastically improves the overall efficiency of the maintenance department.

Image (06) : Prototype of the E-SIGNAL Mobile App: Technician Space Task List and Dashboard



2.2.3. Comprehensive Diagnostic and Intervention Screen .

- **Interface Description:** When a technician clicks on a specific ticket, they access a detailed diagnostic interface. This screen compiles the exact data submitted by the medical staff—including the specific QR code metadata, textual descriptions, attached photographs of the error, and voice recordings.
- **Functional Value:** This is a crucial feature for reducing the **Mean Time To Repair (MTTR)**. By reviewing the multimedia evidence before even arriving at the ward, the technician can accurately anticipate the fault, bring the correct spare parts, and consult the machine's digital history log or manual directly from the app. It bridges the communication gap between clinical observations and technical diagnostics.

◇ Axis Six: Prototype

2.2.4. Intervention Execution and Offline Synchronization (Failsafe) .

- **Interface Description:** Once the repair is complete, the technician uses a simplified form to log the actions taken, register any spare parts consumed, and change the ticket status to "Resolved."
- **Functional Value:** Recognizing the architectural realities of Algerian hospitals—where technical rooms or basements often suffer from dead Wi-Fi or cellular zones—this interface incorporates an **Offline Synchronization Module**. Technicians can fully process and close a ticket without an internet connection. The application securely stores the intervention data locally and automatically synchronizes it with the central cloud server the moment connectivity is restored. This ensures zero data loss and immediate notification to the medical staff that their equipment is ready for use.

2.2.5. Spare Parts Requisition and Supplier Management Interface

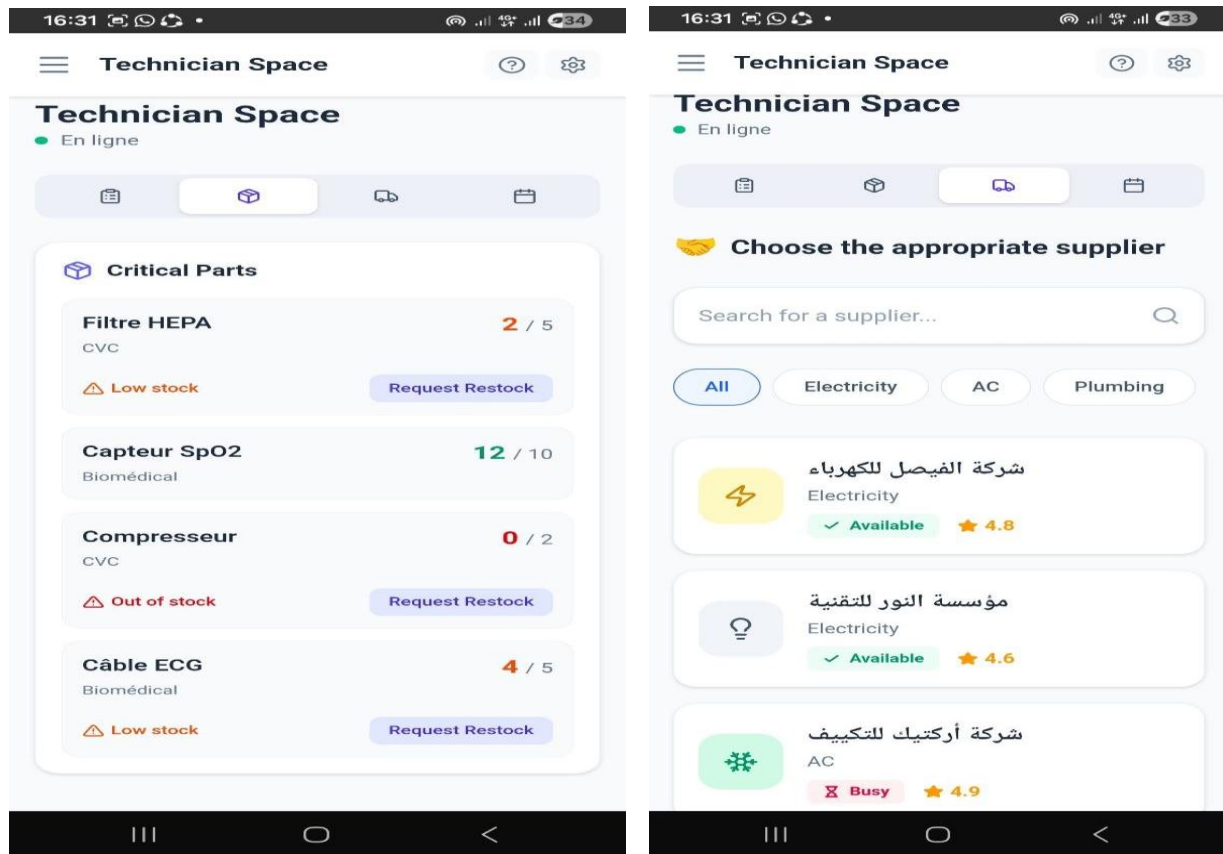
Interface Description: In the event that a technician diagnoses a fault (e.g., a defective compressor in a ventilator) and discovers the required spare part is out of stock in the hospital's internal inventory, this interface allows them to generate a digital "Material Requisition" instantly from the field.

- **Functional Value:** This feature elevates E-SIGNAL into a comprehensive Computerized Maintenance Management System (CMMS). The interface is linked to a B2B database of certified medical equipment suppliers and distributors. The technician can browse available components, select the appropriate supplier based on delivery speed or quality, and digitally forward the request to the Maintenance Director or Procurement Department for immediate validation. This streamlined logistical workflow drastically reduces the administrative delays associated with procurement, thereby minimizing critical equipment downtime.

Image (07) : Prototype of the E-SIGNAL Mobile App: Technician Space Critical Parts Inventory

Image (08) : Prototype of the E-SIGNAL Mobile App: Technician Space Supplier Selection Interface

◇ Axis Six: Prototype



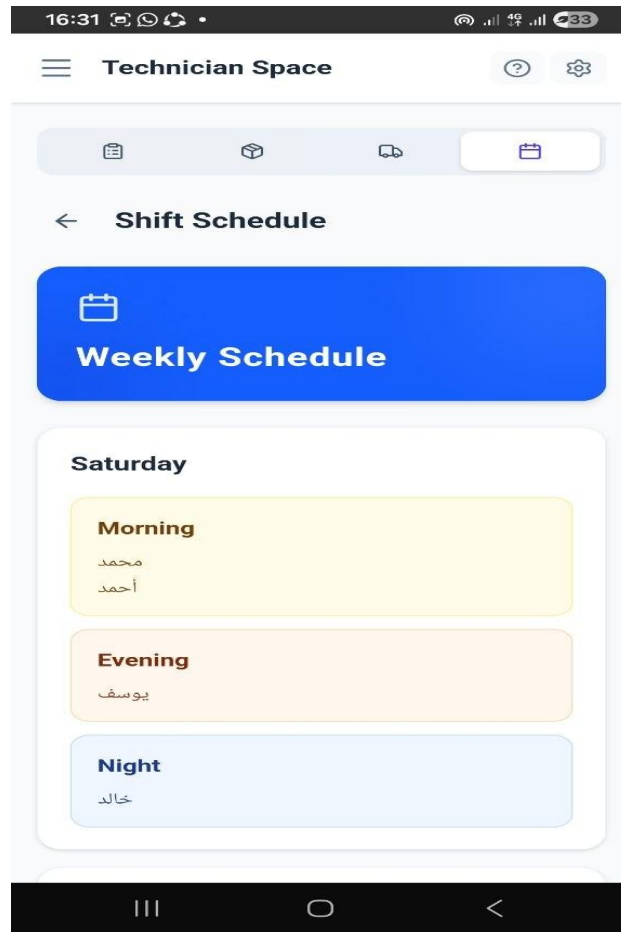
2.2.6. Shift Management and On-Call Scheduling Dashboard

Interface Description: An integrated, interactive calendar displaying the real-time working shifts and operational status of the entire biomedical engineering and technical team (e.g., *Available*, *On Leave*, *Night Shift*, *On-Call*).

- **Functional Value:** This functionality is vital for ensuring uninterrupted 24/7 technical coverage within the hospital. Its true strength lies in its integration with E-SIGNAL's **Smart Routing Algorithm**. If a highly critical breakdown is reported at 3:00 AM in the Intensive Care Unit, the system does not send a generic alert to all staff. Instead, it reads the scheduling dashboard and dispatches a high-priority push notification exclusively to the specific technician designated as "On-Call" for that exact shift. This ensures targeted accountability and rapid crisis response.

Image (09) : Prototype of the E-SIGNAL Mobile App: Technician Space Shift Schedule Interface

◇ Axis Six: Prototype



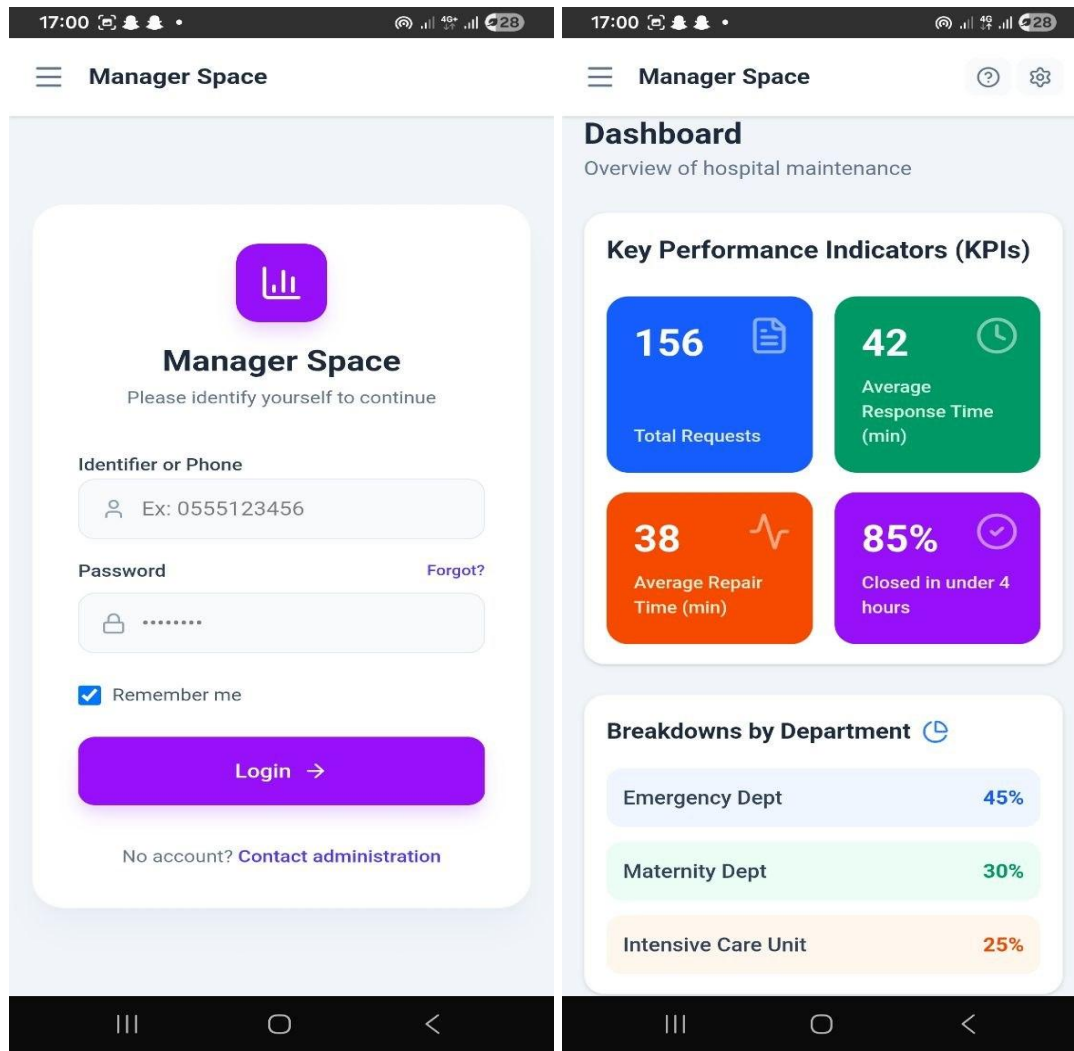
2.3. The Manager and Administrative Interface (Decision-Support Dashboard)

The third and final module of the **E-SIGNAL** prototype is designed for Hospital Managers, Maintenance Directors, and Administrative Supervisors. Unlike the operational interfaces of the Medical Staff and Technical Teams, this dashboard acts as the **Central Control Tower**. It provides a macro-level view of the entire hospital's maintenance ecosystem, transforming raw operational data into strategic decision-making tools.

Image (10) : Prototype of the E-SIGNAL Mobile App: Manager Space Login Interface

Image (11) : Prototype of the E-SIGNAL Mobile App: Manager Space Dashboard and KPIs

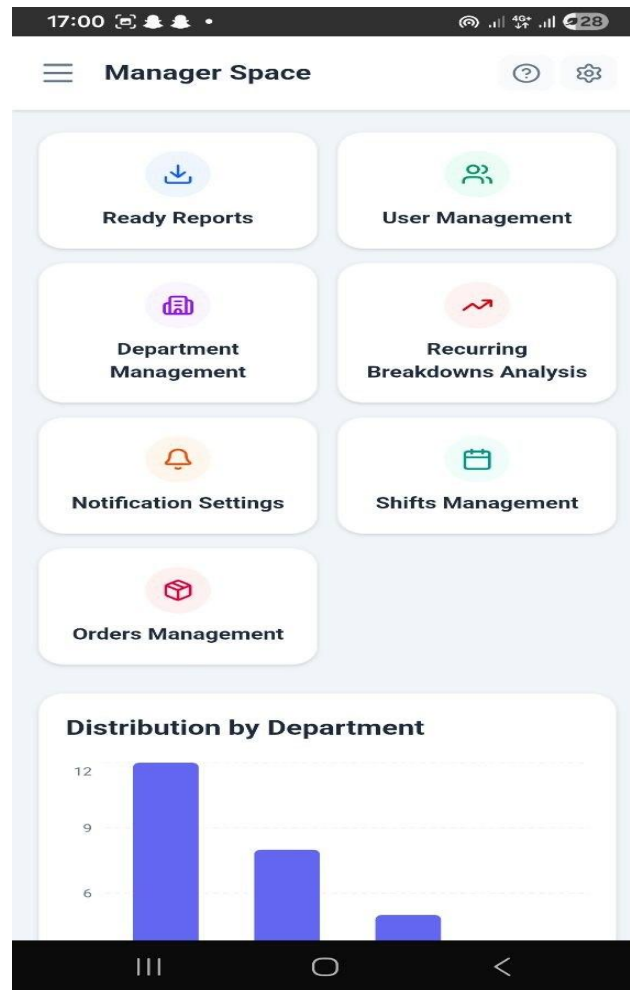
◇ Axis Six: Prototype



Here is a clear and concise breakdown of the Manager's core functionalities and how they interconnect with the other profiles:

◇ Axis Six: Prototype

Image (12) : Prototype of the E-SIGNAL Mobile App: Manager Space Management Modules Interface



2.3.1. User and Department Access Management .

- **Functionality:** The manager has full administrative control to register, modify, or deactivate user profiles (doctors, nurses, technicians) and map them to specific hospital departments (e.g., ICU, Radiology, Pediatrics).
- **Interconnection:** This is the foundational database. By correctly mapping users to departments, the system ensures that when a **Medical Staff** member reports a breakdown, the ticket is automatically tagged with the correct geographical location within the hospital.

2.3.2. Shift Scheduling and On-Call Management

- **Functionality:** A digital scheduling matrix where the manager defines the working hours, night shifts, and on-call rotations for the biomedical engineering team.

◇ Axis Six: Prototype

- **Interconnection:** This directly powers the **Technical Team's** workflow. When an urgent ticket is generated, the Smart Routing algorithm consults this exact schedule to dispatch the alert only to the technician currently on duty, preventing communication delays.

2.3.3. Procurement and Supply Request Validation.

- **Functionality:** A centralized inbox where the manager reviews "Material Requisitions" submitted by technicians in the field. The manager can instantly approve, reject, or modify the purchase order for spare parts before sending it to the hospital's financial department or external suppliers.
- **Interconnection:** This closes the logistical loop. It empowers the **Technical Team** to request parts digitally from the field, while ensuring the **Manager** retains strict control over the maintenance budget.

2.3.4. Tracking Recurring Breakdowns and Asset Health .

- **Functionality:** An analytical interface that flags biomedical assets with unusually high failure rates. It calculates the cumulative cost of repairing a specific machine over time.
- **Interconnection:** This is a vital financial tool. It helps the administration decide whether an aging piece of equipment should be repaired again or entirely replaced, thereby optimizing the hospital's capital expenditure (CAPEX).

2.3.5. Smart Notifications and Escalation Alerts .

- **Functionality:** A high-priority alert system that notifies the manager of critical bottlenecks. For example, if a life-saving device (like an incubator) remains unassigned for more than 30 minutes, or if a ticket exceeds its target Mean Time to Repair (MTTR), the manager receives an escalation alert.
- **Interconnection:** Ensures total accountability. It allows the manager to oversee the **Technical Team's** responsiveness without micromanaging their every move.

2.3.6. Automated Analytics and Ready-Made Reports .

- **Functionality:** With a single click, the manager can generate comprehensive, exportable performance reports (PDF/Excel). These reports visualize Key Performance Indicators (KPIs) such as average repair times, technician efficiency, and overall equipment downtime across the institution.
- **Interconnection:** These ready-made reports are essential for high-level meetings. They provide concrete, data-driven evidence of the maintenance department's performance, which is invaluable when presenting budgetary needs to the Hospital Director or the regional Health Directorate (DSP).

◇ Axis Six: Prototype

By integrating these three distinct yet deeply interconnected profiles—the speed-optimized **Medical Staff** interface, the task-oriented **Technical Team** dashboard, and the data-driven **Manager** control tower—the E-SIGNAL prototype proves its viability as a comprehensive Computerized Maintenance Management System (CMMS). It successfully demonstrates how digitalizing workflows can eliminate bureaucratic friction, accelerate crisis response, and ultimately improve the quality of patient care in Algerian healthcare institutions.

[Access to the E-SIGNAL application prototype:](#)

https://drive.google.com/file/d/17ijALsYmFafXhjW98ycuX_mh6LDfLO6E/view?usp=sharing

General Conclusion

General Conclusion

At the end of this graduation project, the development of the E-SIGNAL platform has demonstrated the feasibility of an innovative digital solution dedicated to the management of hospital maintenance in Algeria. Through a structured methodology, we were able to identify a real operational need within healthcare facilities, design a functional Computerized Maintenance Management System (CMMS), and validate its relevance with a sample of target users, including medical and technical staff.

The obtained results have confirmed the existence of significant strategic and economic potential, particularly in public and private hospitals seeking flexible and reliable solutions to reduce equipment downtime and optimize operational costs. However, perspectives for improvement remain, notably regarding the development of institutional partnerships, the automation of predictive maintenance using artificial intelligence, the full integration with Hospital Information Systems (HIS), as well as the extension of the platform to other regions across the country.

Thus, E-SIGNAL positions itself as a promising initiative in the field of digital health and hospital management in Algeria, combining institutional efficiency, technological innovation, and economic viability. This thesis paves the way for future research and developments to enrich the digital infrastructure and healthcare management ecosystem in our country

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Abstract

English :

Healthcare institutions in Algeria face continuous challenges in managing medical equipment breakdowns, which can impact the quality of care. In this context, the E-SIGNAL project aims to develop an innovative digital system and mobile application that allows for the management and reporting of malfunctions and maintenance problems in both public and private healthcare facilities. This thesis examines the strategic, economic, and technological feasibility of the project through a methodology that combines literature review, a field survey (at the Mother and Child Hospital in Tlemcen), and strategic analysis tools (SWOT, PESTEL). The results reveal a strong development potential for modernizing hospital infrastructure and providing a relevant digitized response to maintenance needs. The project fits within a comprehensive hospital digital transformation strategy, valuing both medical staff and technical intervention teams. This thesis also provides recommendations for the implementation and future evolution of the project.

Keywords: *E-SIGNAL, medical equipment, hospital maintenance, mobile application, malfunction reporting, digitalization, healthcare institutions, Algeria.*

Français :

Les établissements de santé en Algérie font face à des défis continus dans la gestion des pannes d'équipements médicaux, ce qui peut impacter la qualité des soins. Dans ce contexte, le projet E-SIGNAL vise à développer un système numérique et une application mobile innovante permettant la gestion et le signalement des pannes et des problèmes de maintenance dans les établissements de santé publics et privés. Ce mémoire analyse la faisabilité stratégique, économique et technologique du projet à travers une méthodologie combinant étude documentaire, enquête terrain (au niveau de l'EHS Mère et Enfant de Tlemcen) et outils d'analyse stratégique (SWOT, PESTEL). Les résultats démontrent un fort potentiel de développement pour moderniser les infrastructures hospitalières et apportent une réponse pertinente aux besoins de réactivité grâce au digital. Le projet s'inscrit dans une logique de transformation numérique hospitalière, en valorisant à la fois le personnel médical (pour le signalement) et les équipes techniques (pour l'intervention). Ce mémoire propose également des recommandations pour la mise en œuvre du projet et son évolution future.

Mots-clés : *E-SIGNAL, équipement médical, maintenance hospitalière, application mobile, signalement des pannes, digitalisation, établissements de santé, Algérie.*

تواجه المؤسسات الصحية في الجزائر تحديات مستمرة في تسيير أعطال المعدات الطبية، مما قد يؤثر على جودة الرعاية إلى تطوير نظام رقمي وتطبيق محمول مبتكر يسمح بتسيير والتبليغ E-SIGNAL المقدمة. وفي هذا السياق، يهدف مشروع عن الأعطال ومشاكل الصيانة في المؤسسات الصحية العامة والخاصة. يتناول هذا البحث دراسة الجدوى الاستراتيجية والاقتصادية والتكنولوجية للمشروع، من خلال منهجية تجمع بين الدراسة الوثائقية، والمسح الميداني (على مستوى المؤسسة وتُظهر النتائج). (SWOT, PESTEL) الاستشفائية المتخصصة للأم والطفل بتلمسان)، واستخدام أدوات التحليل الاستراتيجي وجود إمكانيات كبيرة لتحديث البنية التحتية الاستشفائية، واستجابة ملائمة للحاجيات التشغيلية من خلال الرقمنة. يندرج المشروع ضمن منطق التحول الرقمي للمستشفيات، مع إضفاء قيمة مضافة لكل من الطاقم الطبي (المُبلّغ) والفرق التقنية. ويقتراح هذا البحث أيضاً توصيات عملية لتجسيد المشروع وتطويره مستقبلاً

المعدات الطبية، صيانة المستشفيات، تطبيق محمول، التبليغ عن الأعطال، الرقمنة، E-SIGNAL. **الكلمات المفتاحية**
المؤسسات الصحية، الجزائر

Appendices



الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي والبحث العلمي
المدرسة العليا لإدارة الأعمال تلمسان
حاضنة الأعمال



الرقم: 012/م.ع.ا.ح.ا. 2026

شهادة توظيف المشروع

تشهد مديرة حاضنة الأعمال للمدرسة العليا لإدارة الأعمال - تلمسان أن المشروع:

E-SIGNAL

للطلبة التالية أسمائهم:

الاسم واللقب	السنة	التخصص	المؤسسة
بن حمو محمد	الثالثة من الطور الثاني	إدارة الخدمات الصحية	المدرسة العليا لإدارة الأعمال تلمسان
بن عبد الله صلاح الدين	الثالثة من الطور الثاني	إدارة الخدمات الصحية	المدرسة العليا لإدارة الأعمال تلمسان

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سعيد مريم	أستاذ محاضر ب	اعلام آلي	مشرف رئيسي 2
بوكليخة ياسين	أستاذ محاضر	تسيير	مشرف مساعد

مُسجل ومُؤطن على مستوى حاضنة الأعمال للمدرسة العليا لإدارة الأعمال تلمسان للسنة الجامعية: 2026/2025 ، في إطار
القرار الوزاري 1275 المؤرخ بتاريخ 27 سبتمبر 2022 المعدل و المتعمم بالقرار الوزاري 008.

سلمت هذه الشهادة بطلب من المعني لإدلاء بها في حدود ما يسمح به القانون.

التاريخ: 2026/05/05



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الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التجارة و ترقية الصادرات

المركز الوطني للسجل التجاري

الفرع المحلي لولاية تلمسان

شهادة تسجيل الإسم التجاري أو العنوان الإجتماعي

رقم الشهادة : 788307

إن المركز الوطني للسجل التجاري و تبعا للطلب المقدم من طرف ،

صاحب(ة) التسمية : بن حمو محمد

الممثل (ة) القانوني : ش,م,ب إسنيالمون

العنوان الشخصي : شارع الإخوة بلعاني 05 المحمدية - معسكر

يُشَهِدُ أَنْ تَسْمِيَةَ الشَّرْكَاءِ أَوْ الْإِسْمَ التِّجَارِيَّ التَّالِيَّ :

إسبانيا المون

قد تم تسجيله (ها) بالبطاقة الوطنية لتسميات الشركات والأسماء التجارية التي يديرها المركز الوطني للسجل التجاري .

تعد هذه الشهادة بمثابة حجز لهذه التسمية أو الاسم التجاري ، وذلك لمدة ستة (06) أشهر ابتداء من تاريخ تسجيلها .

هذه الشهادة صالحة للتسجيل في السجل التجاري على مستوى التراب الوطني , وفي حالة عدم استعمالها في الأجل الممنوحة سنة (06) اشهر تلغى تلقائيا.

الإسم التجاري أو العنوان الإجتماعي بالحروف اللاتينية :

SPAS ESIGNALEMENT

حررت بتاريخ : 03/05/2026

حررت من طرف : مقال غربي فزيلة

لامضاء

بوتيسسي فاطمة الزهراء

رئيس مكتب لسيير

السجل التجارى

