

الجمهورية الجزائرية الديمقراطية الشعبية

PEOPLE'S DEMOCRATIC REPUBLIC OF ALGERIA

وزارة التعليم العالي والبحث العلمي

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

جامعة أبي بكر بلقايد – تلمسان

University Aboubakr Belkaïd – Tlemcen –

Faculty of TECHNOLOGY



DISSERTATION

Presented for obtaining the **diploma** of **MASTER**

In: Biomedical Engineering

Speciality: Medical Imaging

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Theme

Development of a Web Application for Digital Patient
Record Management

Presented on July 17th, 2024, in front of the board of jury :

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Academic Year : 2023 / 2024

Acknowledgements

الحمد لله الذي بنعمته تتم الصالحات

We would first like to thank ALLAH, the Almighty and Merciful, who gave us the strength and patience to complete this modest work.

The completion of this dissertation was made possible through the support of several people to whom we would like to express our gratitude. We wish to thank them here.

We sincerely thank Prof. Amel FEROUÏ who, as our supervisor, was always attentive and very available throughout the completion of this work. We are grateful for her inspiration, help, the time she graciously dedicated to us, and the trust she placed in us by agreeing to supervise this work.

A big thank to our co-supervisor, Eng. Oussama SIKADDOUR, for dedicating his time to the development of the application and explaining everything related to it.

We are very appreciative to the jury members for the time and effort they dedicated to reviewing and supervising our dissertation. Their expertise, insightful feedback, and constructive critiques have been instrumental in shaping our work.

We would like to extend our appreciation to our teachers of biomedical engineering department [UABT] and the Student Center [i2E], whose lectures, seminars, and discussions have provided us with a solid foundation of knowledge and essential skills for this project.

We do not forget our families for their contribution, support, and patience.

Finally, we extend our most sincere thanks to all our relatives

Dedication

Alhamdulillah. I thank Allah who gave me the strength, patience and guidance throughout all these five university years and provided me wisdom to pursue this work.

I would like to dedicate this work to my beloved parents "Hamid" and "Hind", whose unwavering support, encouragement, and trust in my abilities have been my driving force.

To my lovely and only sister "Dima" who's my sunshine and first fan, thank you for believing in me and always cherishing my achievements.

To my aunty "Leila", her husband and daughters who embraced me during the last two years and never let me feel far from home.

To my grandmothers whose constant prayers have always protected me and guided me during my whole life. May they be blessed with long life and good health.

I also extend my deepest gratitude to my uncle "Dr.Zoheir", aunties "Dr.Ihcene", "Eng.Rihab", "Atty.Lina" and my little cousins, for their endless love and support. They have stood by me through every challenge and celebrated every success. This achievement is as much theirs as it is mine.

Special thanks to my friends "Eng.Mohamed.F" and "Eng.Tarek.B" whose invaluable help made this dissertation what it is. They never let me down, answered every question, and provided immense mental support. Your encouragement and assistance have been instrumental in this accomplishment.

A heartfelt thank you to my yellow who always push me to be the best version of myself.

To all those who have contributed, directly or indirectly, in the completion of this work. Thank you. Finally, I can't forget my partner "Razane" for her fellowship. You made our years joyful and full of adventures. We have experienced a lot together as friends and roommates. I wish you the best in your life.

Douaa

Dedication

Praise and thanks be to God first

To those who lit my path

To my parents Touatit Messouad and Briki Sihem, inexhaustible sources of love and support, who passed on to me the values that have guided my journey.

To my brother Touatit Ramiz, pillar of my life, who have always been there for me, in good times and in bad times.

To my friends, invaluable traveling companions, who shared my joys and my sorrows, and who always believed in me.

To my mentors, who passed on their knowledge and passion to me, and who inspired me to strive for excellence.

To everyone who contributed to my success

To my research supervisors, who supervised me with patience and kindness, and who allowed me to develop my research skills.

To my laboratory colleagues, who shared their knowledge and expertise with me, and who helped create a stimulating and enriching work environment.

To the institutions that supported me, funded my research, and provided me with access to valuable resources and opportunities.

I express my deep gratitude to all those who contributed to my achievement.

It is thanks to your unwavering support that I was able to carry out this research work and reach this important milestone in my life.

I dedicate this defense to you as a sign of my eternal gratitude.

Touatit Razane

ملخص

كانت إدارة ملفات المرضى تحدياً دائماً للعاملين في مجال الصحة داخل المستشفيات و المؤسسات الصحية. يتضمن ذلك متابعة المرضى وأرشفة تاريخهم الطبي، وفحوصات التصوير الطبي، والإقامات الطبية، والتشخيصات، و بروتوكولات العلاج، والتي تعد معلومات حيوية لا غنى عنها في البيئة الاستشفائية وتؤثر على تجربة المرضى وجودة الرعاية المقدمة لهم. و عليه، للتغلب على هذه التحديات وتحسين الحياة اليومية للأطباء، لابد من رقمنة القطاع الطبي باستخدام تكنولوجيا المعلومات.

يهدف هذا البحث إلى إنشاء منصة ويب لإنشاء وإدارة ملفات المرضى الرقمية. تجمع هذه المنصة كل المحتوى الموجود في النسخ الورقية للملفات الطبية بالإضافة إلى إمكانية توليد رموز فريدة، وتعديل وتحديث المعلومات، وكتابة تشخيصات الإقامات الطبية مع تحديد الغرفة والسريير الخاصين بالمريض المقيم في المستشفى، وتحميل الصور الطبية وكتابة التقارير في نفس النافذة.

تتكون المنصة من مساحتين رئيسيتين: مساحة السكرتارية ومساحة الأطباء. السكرتير مسؤول عن إنشاء ملف المريض الرقمي وإدخال جميع المعلومات اللازمة، والتي تشارك بعد ذلك في مساحة الأطباء لأداء المهام المختلفة.

كلمات مفتاحية: ملف المريض الرقمي، تطبيق ويب، تطوير الويب، نظام إدارة قواعد البيانات.

Abstract

Managing patient records has always been a major challenge for health-care professionals within hospitals. Tracking patients, archiving their medical history, medical imaging exams, hospital stays, diagnoses, and treatment protocols represent crucial information that directly impacts the patient experience and the quality of care provided. To overcome these challenges and improve the daily lives of doctors, it is imperative to digitize the medical sector by utilizing information technology.

This dissertation aims to design a web platform dedicated to the creation and management of digital patient records. This platform integrates the entire content of paper medical records while offering the ability to generate unique codes, modify and update information, record diagnoses from medical stays specifying the patient's room and bed, upload medical images, and write reports within a single interface.

The platform is divided into two main areas: the secretary area and the doctor area. The secretary is responsible for creating the digital patient record and entering all necessary information, which is then shared in the doctor area to perform various tasks.

Key words: *digital patient record, web application, web development, database management system.*

Résumé

La gestion des dossiers patients a toujours constitué un défi majeur pour les professionnels de santé au sein des établissements hospitaliers. Le suivi des patients, l'archivage de leurs antécédents médicaux, les examens d'imagerie médicale, les séjours hospitaliers, les diagnostics et les protocoles de traitement représentent des informations cruciales qui impactent directement l'expérience des patients et la qualité des soins qui leur sont prodigués. Afin de surmonter ces défis et d'améliorer le quotidien des médecins, il est impératif de numériser le secteur médical en recourant aux technologies informatiques.

Ce mémoire a pour objectif la conception d'une plateforme web dédiée à la création et à la gestion des dossiers patients numériques. Cette plateforme intègre l'ensemble du contenu des dossiers médicaux papier, tout en offrant la possibilité de générer des codes uniques, de modifier et de mettre à jour les informations, d'enregistrer les diagnostics des séjours médicaux en précisant la chambre et le lit du patient hospitalisé, de télécharger les images médicales et de rédiger les comptes rendus au sein d'une interface unique.

La plateforme est décomposée en deux espaces principale espace secrétaire et espace médecin. Le secrétaire est responsable à la création du dossier patient numérique et l'introduction de toutes les informations nécessaires qui ensuite se partagent dans l'espace des médecins pour effectuer les différentes tâches.

Mots clés : *dossier patient numérique, application web, développement web, , système de gestion de base de données.*

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List of Abbreviations

RSM:	Response Surface Methode
DPR:	Digital Patient Record
DBMS:	Database Management Systems
CMS:	Content Management Systems
WWW:	World Wide Web
URL:	Uniform Resource Locator
DNS:	Domain Name Serverg
HTTP:	Hypertext Transfer Protocol
HTML:	HyperText Markup Language
CSS:	Cascading Style Sheets
JS:	JavaScript
TCP:	Transmission Control Protocol
IP:	Internet Protocol
SSD:	Solid State Drive
ISP:	Internet Service Provider
AMA:	American Medical Association
HIPAA:	Health Insurance Portability and Accountability Act
GUI:	Graphical User Interface
CLI:	Command-Line Interface

General Introduction

In the rapidly evolving panorama of modern healthcare, the effective management and usage of digital patient records (DPRs) have emerged as a cornerstone of delivering quality, efficient, and patient-centric services. As Algeria maintains to make strides in its digital transformation agenda, it is time to deploy the power of technology to revolutionize the way public hospitals manage and provide patient data.

The importance of digitalization inside the Algerian healthcare sector cannot be overstated. Currently, most of Algerian public hospitals rely primarily on paper medical records; this system is not only slow, impractical and prone to errors but also poses significant challenges in terms of data accessibility, continuity of care, and informed decision-making. This out-dated approach now not only prevents the progress of the overall efficiency of the healthcare system but also limits the ability of medical professionals to provide the highest quality of care to patients.

By transitioning to a centralized, web-based DPR management platform, Algerian public hospitals can release several advantages that will positively impact both healthcare specialists and the population they serve. Such a system would enable coherent data sharing, real-time access to medical histories and archives, and advanced analytics capabilities - all of which are crucial in delivering personalized, data-driven healthcare. Moreover, in future perspectives, the integration of cutting-edge digital technologies, consisting of cloud computing, mobile programs, and cyber security measures, would enhance the general security, scalability, and accessibility of patient records, ensuring the confidentiality and integrity of sensitive medical information.

Beyond the functional advantages, the implementation of a robust DPR management system in Algerian hospitals would also contribute to the wider digital transformation agenda of the country. By embracing the power of technology, the healthcare sector can encourage the development of digital literacy, adapting to it, fostering innovation, and empowering healthcare professionals to deliver more efficient and effective services. This, in turn, would strengthen the overall resilience and responsiveness of the Algerian healthcare system, ulti-

mately benefiting the well-being of the nation's citizens.

This project proposal outlines a comprehensive plan to develop, expand and deploy an innovative, web-based DPR management platform customized to the specific needs and challenges of the Algerian public healthcare system. By leveraging the latest advancements in digital technologies, this initiative aims to pave the way for a more connected, data-driven, and patient-centric healthcare landscape in Algeria, setting the stage for a healthier and more prosperous future.

Problem Statement

Technology has emerged in almost all domains. The Algerian healthcare sector is experiencing a significant leap in digitalization, making it crucial to keep up with these changes. After visiting some units at CHU Tlemcen (University Hospital Center), we discovered that the Nuclear Medicine Unit was divided into two different establishments (the cancer center ‘CLCC CHU Tlm’ and ‘CHU Tlm’), with medical equipment in two separate locations. Consequently, patients and medical staff (doctors and technicians) had to shuttle between the two, leading to confusion in creating medical records and maintaining the order and information assurance of each patient.

The idea for this project arose from these challenges. Our primary aim is to create a paperless environment and reduce document transactions as much as possible. This will not only help doctors access their patients’ files and entire medical history with a single click but also have a positive ecological impact.

Eventually, after listening to doctors describe the challenges they face daily in their workplace, we started thinking about how to meet their needs such as: How can we create a single medical record for each patient that contains all their medical images and reports, both new and old, without requiring them to bring all their medical files and papers? How can we store previous medical images? How can we access patients’ files from anywhere to save time? How can we update patient information efficiently?

To solve these problems, we decided to combine two domains: Web Development and Medical Imaging Informatics. We created a platform called “MedHub” to address the daily practices of medical staff, making it easier and more practical by integrating a web-based electronic medical records management system.

Chapter 1

General Presentation of the Patient File and DBMS

1.1 Introduction

The Patient File and DBMS (Database Management System)

In healthcare, effective management of patient information is crucial. The digital patient record (DPR) has become the preferred tool for storing and organizing this data. At the same time, database management systems (DBMS) play a key role in the construction and maintenance of these Individual Patient Records.

1.2 History of Medical Files

The concept of keeping medical records dates back to ancient times. In ancient Egypt, records recorded medical information on papyrus scrolls. In ancient Greece, Hippocrates emphasized the importance of documenting patient histories and observations. During the Middle Ages, medical records were often kept by monasteries and hospitals. However, these records were often incomplete and unreliable.

In the 18th century, the development of standardized medical forms and the rise of scientific medicine led to more systematic record-keeping. In the 19th century, the invention of the typewriter and the telephone made it easier to create and share medical records.

In the 20th century, the advent of computers and digital patient records (DPRs) revolutionized medical record-keeping. DPRs allow healthcare providers to access and share patient information more easily and securely. Key Milestones in the History of Medical Files: 1768:

John Coakley Lettsom, an English physician, publishes the first standardized medical record form.

1848: Florence Nightingale develops a system for collecting and analyzing medical data during the Crimean War.

1902: The American Medical Association (AMA) publishes the first edition of the “Standard Nomenclature of Diseases and Operations.” **1950s:** The development of computers and electronic data processing leads to the creation of early DPR systems.

1970s: The AMA publishes the first edition of the "Current Procedural Terminology" (CPT) codes.

1990s: The Health Insurance Portability and Accountability Act (HIPAA) is passed, establishing federal standards for the privacy and security of medical records.

2000s: The widespread adoption of DPRs begins.

Today, medical files are an essential part of healthcare. They provide a comprehensive record of a patient's health history and facilitate communication between healthcare providers. DPRs are becoming increasingly common and offer many advantages over paper-based medical records

1.3 Medical Record

The medical record is a comprehensive, legal and detailed documentation of an individual's medical history and care over time within one or multiple healthcare settings. It includes personal information, medical history, medications, immunizations, diagnostic test results, treatment plans, progress notes, hospitalization records, consent forms, and correspondence between healthcare providers. Medical records are essential for ensuring continuity of care, facilitating accurate diagnosis and treatment, supporting legal and regulatory requirements, and providing valuable data for research and quality improvement initiatives.

1.4 Limitations of the classical form of the medical record

The classical form of the medical record, which is a paper-based record, has several limitations, including:

Limited accessibility: Paper records are stored in a physical location, which limits access to information for healthcare providers who are not on-site.

Lack of structure and organization: Paper records can be bulky and difficult to organize, making it time-consuming and laborious to find specific information.

Compromised security and confidentiality: Paper records are vulnerable to theft, loss, and accidental damage. Patient confidentiality can be compromised if records are not properly secured.

Lack of interoperability: Paper records are not easily interoperable with other health-care information systems, which limits communication and coordination between different healthcare providers.

High costs: Managing paper records involves significant costs related to storage, handling, and duplication.

Environmental impact: The production and use of paper records contribute to deforestation and other environmental problems.

These limitations can have a negative impact on the quality of patient care and the efficiency of the healthcare system.

The computerization of medical records can overcome these limitations and improve patient care.

1.5 The Computerized Patient File: Revolutionizing Healthcare

The traditional paper-based medical record is rapidly being replaced by the computerized patient file, also known as a Digital Patient Record (DPR). This digital transformation brings significant advancements to healthcare delivery.

1.5.1 DPR: A Digital Revolution

An DPR is a secure, digital version of a patient's medical history. It encompasses all the critical information found in a traditional chart, including:

- Demographics.
- Medical history.
- Allergies and immunizations.
- Medications.

- Physical examinations.
- Laboratory results.
- Imaging studies.
- Diagnoses.
- Treatment plans.

1.5.2 DPRs offer substantial advantages

- **Enhanced Accessibility:** Authorized healthcare providers can access a patient's DPR from anywhere, at any time, improving continuity of care.
- **Improved Quality of Care:** Complete and up-to-date information in DPRs empowers healthcare professionals to make informed decisions for better patient outcomes.
- **Reduced Costs:** DPRs eliminate the need for duplicate tests and procedures, leading to cost savings for both patients and healthcare institutions.
- **Increased Patient Engagement:** Patients can access their DPRs, allowing them to participate more actively in their own healthcare.
- **Improved Communication and Collaboration:** Secure DPR systems facilitate better communication and collaboration between healthcare providers involved in a patient's care.

1.5.3 Security and Privacy: Top Priorities

DPRs store sensitive patient information, so security and privacy are paramount. Here are some safeguards in place:

- **Access Controls:** Only authorized personnel can access specific patient data based on their roles and permissions.
- **Data Encryption:** Sensitive data is encrypted during storage and transmission to prevent unauthorized access.
- **Regular Audits and Backups:** Regular audits ensure system integrity, and data backups guarantee information recovery in case of technical issues.

1.5.4 The Future of Healthcare

The use of DPRs is steadily increasing, and they are expected to play an even greater role in the future of healthcare. Here are some promising advancements:

- **Interoperability:** Standardized DPR systems will allow seamless information sharing between different healthcare providers, facilitating coordinated care.
- **Integration with AI:** DPR data can be used by AI algorithms to support clinical decision-making, potentially leading to personalized medicine approaches.
- **Patient Empowerment:** DPRs can empower patients to manage their health more effectively through secure access to their medical data.

The transition to computerized patient files is a significant step towards a more efficient, effective, and patient-centered healthcare system.

1.6 Components of an Digital Patient Records (DPRs)

- An DPR is a comprehensive digital record of a patient's health information. It contains all the critical data related to a patient's medical history, including demographics, medical history, allergies, medications, lab results, imaging studies, diagnoses, treatment plans, and more.
- DPRs are designed to improve the quality, efficiency, and coordination of healthcare by providing authorized healthcare providers with instant access to a patient's complete health information.

1.6.1 Key Components of an DPR

- **Patient Demographics:** Basic information about the patient, such as name, date of birth, address, contact information, insurance details, etc.
- **Medical History:** A detailed record of the patient's past and present health conditions, including illnesses, surgeries, hospitalizations, allergies, immunizations, and family health history.
- **Problem List:** A summary of the patient's current health problems or diagnoses.

- Medicines: A list of all medicines the patient is currently taking, including prescription drugs, over-the-counter medicines, herbal supplements, and vitamins.
- Lab Results: Results of all laboratory tests performed on the patient, such as blood tests, urine tests, and imaging studies.
- Imaging Studies: Images from X-rays, MRIs, CT scans, and other imaging procedures.
- Diagnoses: A list of all the patient's current and past diagnoses.
- Treatment Plans: A detailed outline of the patient's current treatment plan, including medications, therapies, and procedures.
- Progress Notes: Documentation of the patient's progress over time, including changes in health status, response to treatment, and new developments.
- Vital Signs: A record of the patient's vital signs, such as blood pressure, heart rate, temperature, and respiratory rate.
- Immunizations: A record of all the immunizations the patient has received.
- Advance Directives: Documentation of the patient's wishes for end-of-life care.
- Functional Status: An assessment of the patient's ability to perform daily activities.
- Social History: Information about the patient's social and environmental circumstances, such as living situation, employment, and family support.
- Mental Health History: A record of the patient's mental health history, including any mental health conditions or diagnoses.

1.6.2 Benefits of Using an DPR

- Improved quality of care through better access to patient information and more accurate diagnoses.
- Increased efficiency by reducing the need for duplicate tests and procedures.
- Enhanced coordination of care between different healthcare providers.
- Improved patient satisfaction by providing patients with access to their own health information.

- Reduced costs through better management of chronic diseases and prevention of unnecessary hospitalizations.

1.7 Patient Record Retention

Patient record retention refers to the practice of storing and maintaining patient records for a specific period of time. This is a legal requirement in most countries, and the specific retention period varies depending on the jurisdiction. The purpose of patient record retention is to:

- Ensure the continuity of care for patients.
- Protect the legal rights of patients and healthcare providers.
- Facilitate medical research and quality improvement initiatives.

There are two main types of patient records:

- Paper-based records: These are traditional medical records that are stored in physical form.
- Digital Patient Records (DPRs) : These are digital records that are stored on a computer system.

The retention period for patient records varies depending on the type of record and the jurisdiction. In general, paper-based records must be retained for a longer period of time than DPRs.

For example, in the United States, the following retention periods apply:

- Paper-based records: 7 years after the date of the last patient encounter.
- DPRs: 6 years after the date of the last patient encounter.

There are a few exceptions to these retention periods. For example, records for patients who are minors must be retained until the patient reaches the age of majority.

Healthcare providers must have a system in place for managing patient records. This system should include procedures for:

- Storing records securely.
- Retrieving records quickly and easily.

- Destroying records at the end of the retention period.

Healthcare providers must also have a policy in place for providing patients with access to their records. This policy should include information on:

- How patients can request access to their records.
- What fees, if any, patients will be charged for accessing their records.
- How long it will take for patients to receive access to their records.

Patient record retention is an important part of healthcare quality and safety. By following the legal requirements and implementing sound record-keeping practices, healthcare providers can help to ensure the continuity of care for patients, protect the legal rights of patients and healthcare providers, and facilitate medical research and quality improvement initiatives.

Here are some additional resources on patient record retention:

- The National Archives and Records Administration (NARA): [<https://www.archives.gov/page-header>]
- The American Health Information Management Association (AHIMA): [<https://www.ahima.org>]
- The American Medical Association (AMA): [<https://www.ama-assn.org>]

1.8 Database

A collection of organized data stored and managed electronically for easy access, retrieval, and manipulation.

Often structured in a formal way (like tables in relational databases) to facilitate efficient searching and analysis.

1.8.1 Additional Databases

- **Types of databases:** There are many different types of databases, including relational databases, NoSQL databases, and object-oriented databases. Each type of database is designed for a specific purpose and has its own strengths and weaknesses.

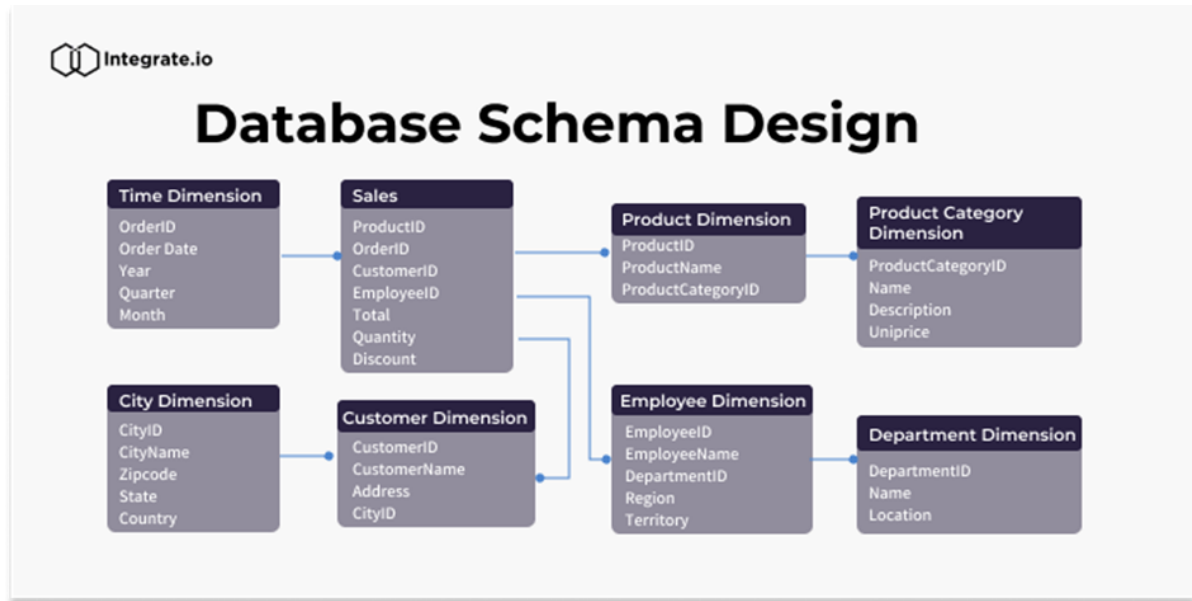


Figure 1.1: Principle diagram of database

- **Database management systems (DBMS):** A DBMS is a software application that allows users to create, manage, and access a database. The DBMS provides a graphical user interface (GUI) or command-line interface (CLI) for interacting with the database.
- **Database applications:** Databases are used in a wide variety of applications, including business, government, healthcare, and education. For example, businesses use databases to store customer information, product information, and financial data. Governments use databases to store information about citizens, such as birth records, tax records, and law enforcement records. Healthcare providers use databases to store patient records, medical research data, and insurance information. Schools and universities use databases to store student records, class schedules and library catalogs.

1.8.2 Benefits of using a database

- **Data storage:** Databases provide a central location for storing data, making it easier to access and manage.
- **Data organization:** Databases organize data in a way that makes it easy to find and use.
- **Data security:** Databases can be used to protect data from unauthorized access.
- **Data integrity:** Databases can be used to ensure that data is accurate and consistent.

- **Data sharing:** Databases can be used to share data with other users.

1.8.3 Challenges of using a database

- **Data complexity:** Databases can be complex to set up and manage.
- **Data security:** Databases can be vulnerable to security breaches.
- **Data costs:** The cost of implementing and maintaining a database can be significant.

Despite these challenges, databases offer a number of potential benefits for businesses, governments, healthcare providers, and educational institutions. Sources : <https://techdevblog.io/get-your-data-fix-with-these-database-concepts-youll-be-hooked/>

1.9 Database Management System (DBMS)

A DBMS is software that allows you to create, manage and access a database. It provides a graphical user interface (GUI) or command line interface (CLI) to interact with the database.

1.9.1 Functions of a DBMS

Creation of the database: The DBMS allows you to define the structure of the database, that is to say the tables, the fields and the relationships between the tables.

- **Data storage:** The DBMS stores the data in the database.
- **Data Access:** The DBMS allows users to access the data in the database.
- **Data Manipulation:** The DBMS allows users to modify, add and delete data in the database.
- **Data protection:** The DBMS protects data against unauthorized access.
- **Data backup and restoration:** The DBMS allows data to be backed up and restored in the event of a breakdown or disaster.

1.9.2 Types de DBMS

- **Relational DBMS** : are the most common types of DBMS. They store data in tables with defined relationships between the tables.
- **NoSQL DBMS**: NoSQL DBMS are designed to store large amounts of unstructured data.
- **Object-Oriented DBMS**: Object-oriented DBMS store data in objects.

1.9.3 DBMS Examples:

- **MySQL**: An open source relational DBMS
- **Microsoft SQL Server**: A commercial relational DBMS
- **Oracle Database**: A commercial relational DBMS
- **MongoDB**: An open source NoSQL DBMS
- **Cassandra**: An open source NoSQL DBMS



Figure 1.2: DBMS examples

1.9.4 Advantages of using a DBMS

- **Data centralization:** A DBMS helps centralize data, making it easier to access and manage data.
- **Improved data security:** A DBMS can protect data from unauthorized access.
- **Improved data integrity:** A DBMS can ensure that data is accurate and consistent.
- **Improved productivity:** A DBMS can help users be more productive by automating tasks such as creating reports and backing up data.

1.9.5 Disadvantages of using a DBMS

- **Cost:** Commercial DBMS can be expensive.
- **Complexity:** DBMS can be complex to configure and manage.

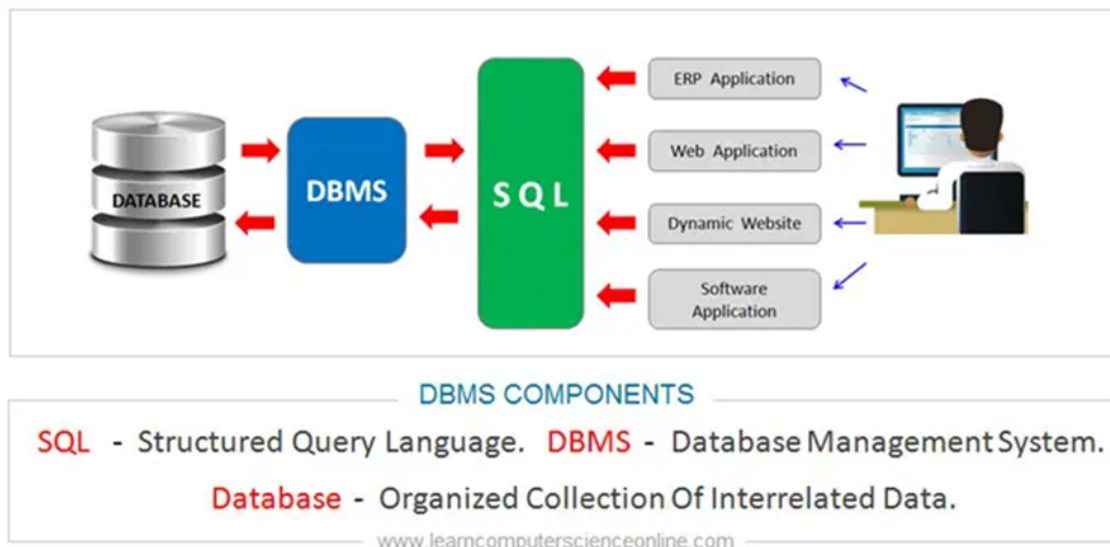


Figure 1.3: Database Management System

1.10 Database Management System (DBMS) Components

Table 1.1 shows the key components of a DBMS :

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Table 1.1: DBMS Components

DBMS Components	Function	Components	Usage
1. Data Storage Manager	Stores database data on disk or other storage media.	• Data File: Stores actual database data. • Index: Data structure that allows quick access to data in the data file.	/
2. Query Processor	Processes user queries and returns results.	• Parser: Breaks the query into its constituent components and determines its meaning. • Optimizer: Determines the most efficient execution plan for the query. • Executor: Runs the execution plan and returns the results.	/
3. Transaction Manager	Ensures that transactions are executed in an atomic, consistent, isolated, and durable (ACID) manner.	• Transaction Log: Records all changes made to the database. • Checkpoint: Saves the state of the database at a given point in time.	/

4. Data Dictionary	Stores information about database data, such as table names, field names, and data types.	/	• Provides information to users and applications about the database structure. • Helps ensure data integrity.
5. Security Manager	Protects the database against unauthorized access, misuse and unauthorized modifications.	• Access Control: Determines who can access the database and what actions they can perform. • Encryption: Protects data from unauthorized access. • Audit: Records user activities in the database.	/
6. Database Utilities	Provides tools for database management, such as backup, restore and reorganization.	/	/
7. Buffer Manager	Stores data in buffer for faster access.	/	/

8. Catalog Manager	Stores information about database objects, such as tables, views, and indexes.	/	/
9. Lock Manager	Manages locks on database data to avoid access conflicts.	/	/
10. Lock Manager	Allows you to restore the database in the event of a breakdown or disaster.	/	/

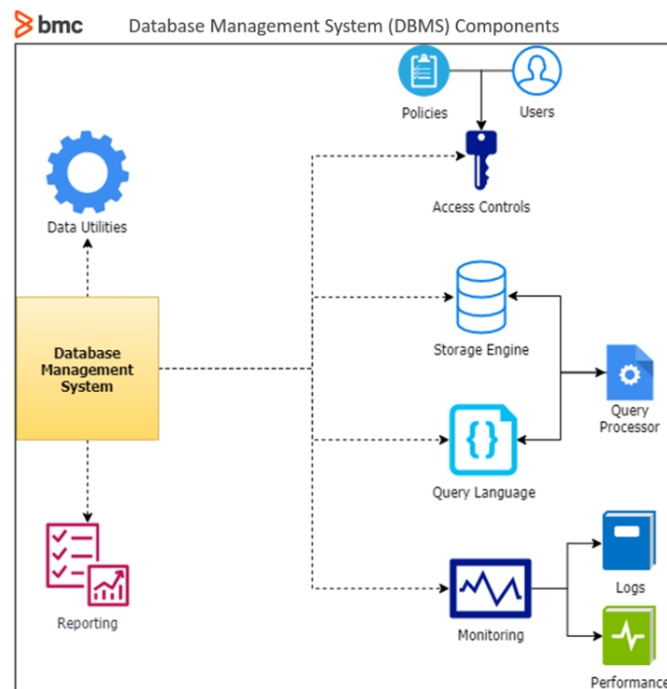


Figure 1.4: the components of the DBMS

1.11 The Role of a Database Management System (DBMS)

A DBMS plays a crucial role in the creation and management of databases. Without a DBMS, effectively running and managing data would not be possible. Acting as an intermediary between the user and the database, a DBMS provides users with access to files stored in a database.

Here are some key roles of a DBMS:

1. **Data Storage:** A DBMS centralizes data storage, making it easier to access and manage data from various sources.
2. **Data Organization:** A DBMS organizes data in a structured manner, often using tables, columns, and relationships, to facilitate efficient searching and analysis.
3. **Data Security:** A DBMS implements security measures to protect data from unauthorized access, modification, or destruction.
4. **Data Integrity:** A DBMS ensures data accuracy and consistency by enforcing data validation rules and constraints.
5. **Data Sharing:** A DBMS provides controlled access to data, allowing authorized users to share and collaborate on information.
6. **Data Backup and Recovery:** A DBMS facilitates data backup and recovery processes, ensuring data availability in case of system failures or data loss.
7. **Data Concurrency:** A DBMS manages concurrent access to data by multiple users, preventing conflicts and ensuring data consistency.
8. **Performance Optimization:** A DBMS optimizes database performance by employing various techniques, such as indexing and query optimization.
9. **Database Administration:** A DBMS provides tools and features for database administration tasks, such as user management, schema modification, and performance monitoring.
10. **Application Development:**

- A DBMS provides a platform for application development, enabling the creation of data-driven applications that leverage the stored data.
- In summary, a DBMS plays a vital role in various aspects of data management, making it an essential tool for organizations that rely on data for their operations and decision-making.

Here are some additional benefits of using a DBMS:

- **Reduced data redundancy:** A DBMS eliminates the need for duplicate data storage, minimizing data inconsistency and storage requirements.
- **Improved data integrity:** A DBMS enforces data integrity rules and constraints, ensuring the accuracy and reliability of data.
- **Enhanced data accessibility:** A DBMS provides user-friendly interfaces and tools for accessing and manipulating data, simplifying data retrieval and analysis.
- **Increased data security:** A DBMS implements various security measures, such as authentication, authorization, and encryption, to protect data from unauthorized access and misuse.
- **Improved data sharing and collaboration:** A DBMS facilitates data sharing and collaboration among authorized users, promoting better decision-making and teamwork.

Overall, a DBMS offers a comprehensive and efficient solution for data management, empowering organizations to harness the full potential of their data.

Chapter 2

Introduction to Web Development

2.1 Introduction

The World Wide Web, or simply the Web, has become an integral part of our lives, providing access to a vast ocean of information and services. Understanding how the Web works and the technologies behind it is essential for anyone who wants to participate in the digital world. This chapter provides a comprehensive introduction to web development, covering the fundamental concepts and technologies that underpin the Web. We will explore the history of the Web, its architecture, the protocols that govern its operation, and the different types of web development. By the end of this chapter, you will have a solid understanding of the building blocks of the Web and how they work together to create the dynamic and interactive online experiences we enjoy today.

2.2 Web introduction

The World Wide Web, often simply referred to as the Web, has become an indispensable tool in our modern world, offering a gateway to a vast and ever-expanding universe of information, services and communication. From accessing news and entertainment to conducting business transactions and connecting with loved ones across the globe, the Web has revolutionized the way we live, work and interact with the world around us. At its core, the Web is a complex system of interconnected networks and technologies that enable the exchange of information between users and servers.

2.2.1 Network definition

A network is a group of interconnected devices that can communicate with each other. This communication can involve sharing resources, exchanging data, or coordinating actions. The simplest network consists of two computers connected via an RJ45 cable, allowing them to exchange information like text, images and other files. Connecting multiple networks through these cables creates a larger, interconnected network known as the internet (figure 2.1).

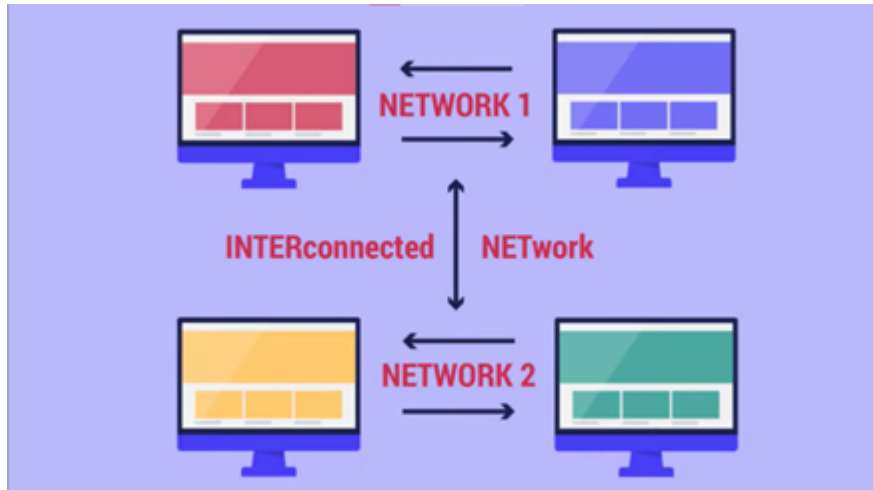
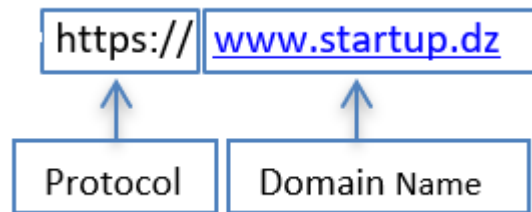


Figure 2.1: The network diagram

The web is a part of the internet, accessible via web browsers such as: Google Chrome, Fire Fox, Opera...etc. but there are some softwares like: Skype and Msn that use the internet but not the web. The web represents a subset of the internet, accessible through specialized software called web browsers. Popular examples of web browsers include Google Chrome, Firefox, and Opera. While the internet serves as the underlying infrastructure, the web provides an accessible interface for users to interact with and navigate through the vast ocean of information it holds. To access to a website and navigate on it we need to write unique identifiers known as URLs on a browser's search bar. A URL (Uniform Resource Locator) acts like a digital map, guiding the browser how and where to retrieve a resource and the desired location on the web. In the context of the World Wide Web (WWW), a URL is often referred to as a web address. It typically comprises two sections:

- **The protocol:** which specifies how the information should be retrieved (e.g., https for secure connections).
- **The domain name:** a human-readable address that points to the specific website (e.g., www.google.com).

Example:



In other way:

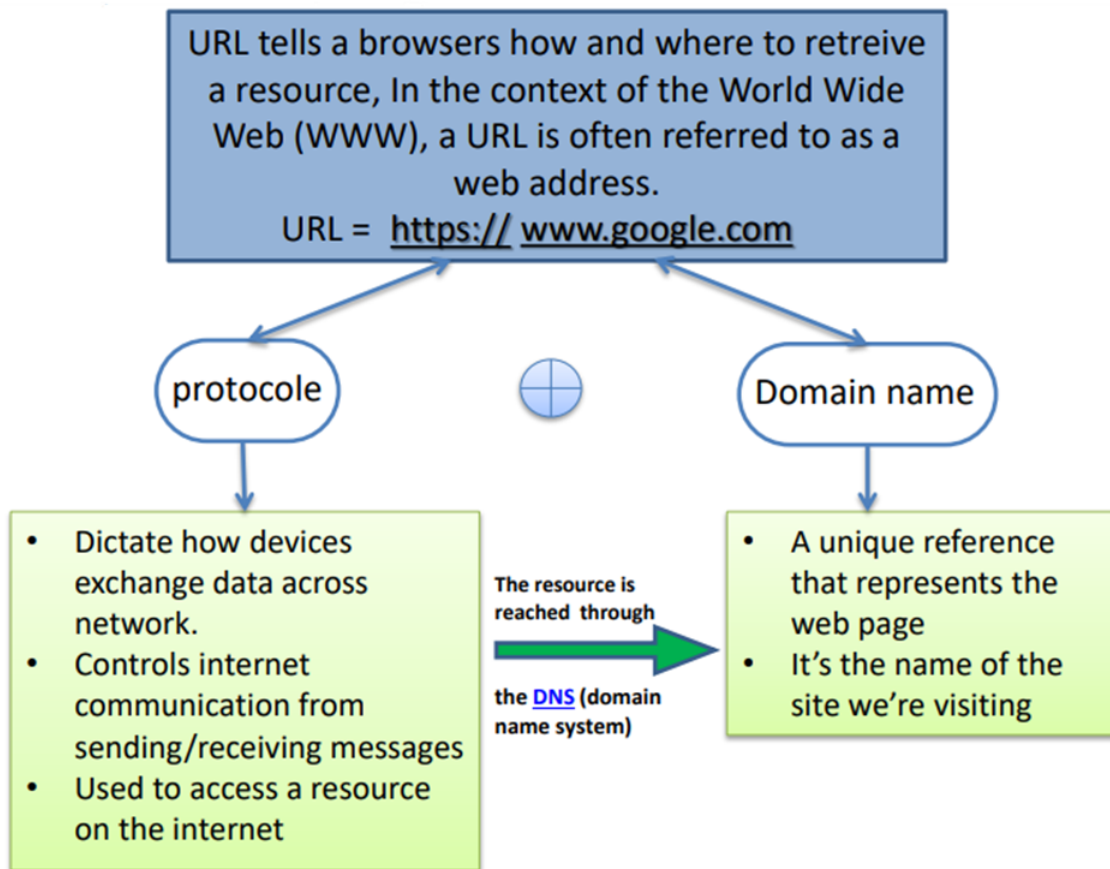


Figure 2.2: The Structure of a URL, roles of Protocols and Domain Names

Browsers are used to visit websites and do activities with them like: log in, view multimedia, visit a page from another, print, send and receive emails... etc. In other words, websites, in essence, serve as digital libraries, offering a wealth of information and resources at our fingertips. Just as we can turn the pages of a physical book, we use our computers, phones or tablets to navigate through web pages using a browser, accessing a variety of content, includ-

ing text, images, videos, and interactive elements. This ease of access and the vast amount of information available have contributed significantly to the web's immense popularity.

2.3 The internet vs the web

While the terms "internet" and "web" are often used interchangeably, they represent distinct, yet interconnected, entities. Delving into their fundamental differences is crucial for navigating the complexities of the digital landscape.

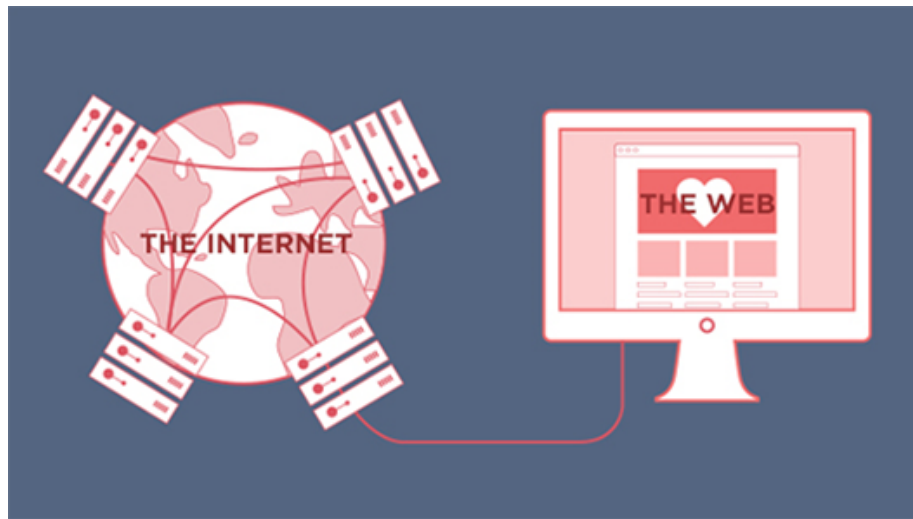


Figure 2.3: The internet and the web

2.3.1 The internet

The Internet is a massive network of networks (ie: interconnected computers) or a networking infrastructure. It connects millions of computers globally, forming a network in which any computer can communicate and exchange information with any other computer as long as they are both connected to the Internet.

Information that travels over the Internet does so via a set of rules known as protocols. Its primary purpose is to facilitate communication and data exchange between devices, enabling information sharing and resource accessibility.

2.3.2 The Web (World Wide Web)

The World Wide Web, or simply the Web, is a way of accessing information through the medium of the Internet. It is an information-sharing model that is built on top of the

Internet. It is a system of interlinked hypertext documents and other resources accessed through web browsers that allow users to navigate and retrieve information. The web utilizes the internet's networking capabilities to retrieve and display web pages identified by URLs (Uniform Resource Locators). The Web uses the HTTP protocol, one of the languages spoken over the Internet to transmit data.

2.3.3 A Comparative Analysis of the internet and the web

Internet is the way computers connect to each other in order to share information. When it first emerged, computers used to make direct calls to each other, but today, network are all around us so computers connect flawlessly. Internet enables many communications such as email file transfer, virtual conferencing, while the common use is accessing the WWW. World Wide Web is a big virtual city with lots of skyscrapers that are represented by web servers.

A server is a computer connected to the internet specially designed to store information and share it. Thus websites are **hosted** on these web servers which contain SSDs (Solid State Drive) filled with information and linking them in an organised way for others to access. A server can host many websites, in order to not get lost and confused in between; each website has its own address that consists of domain names.

The information stored is in web languages like HTML , CSS and JS , when requesting a website our browser takes all the code on the site (hosted on the web server) and turns it into graphs and videos and creates a graphic interface. It is like our translator.

NB: No one owns the web; we may pay an Internet Service Provider (ISP) to gain access, a hosting company to rent a web space or a register to reserve our web address.

The web is a part of our lives because it reflects our society and individuals in structure and content. In which it connects those minds despite of their boundaries, time, space, ethnicity and gender.

After discussing the often conflation between "internet" and "web," highlighting that they are two separate terms but related things, and covering their fundamental concepts, technologies, and applications. We can clearly understand the constant advancement in our technological capabilities and facing new challenges, it is essential to maintain a nuanced comprehension of both the internet and the web. This knowledge not only empowers us to utilize these tools more effectively but also to innovate and contribute to their ongoing evolution. Ensuring that the internet and the web continue to serve as robust, secure, and inclusive platforms will be the key to shaping a positive digital future for all.

Feature	Internet	Web
Definition	A global network of interconnected networks	A system of interconnected documents and resources built on top of the internet
Purpose	Facilitates communication and data exchange between devices	Provides access to information and resources through a user-friendly interface
Underlying technology	Network protocols (e.g., TCP/IP)	Hypertext Transfer Protocol (HTTP)
Access tools	Network devices (e.g., routers, switches)	Web browsers (e.g., Chrome, Firefox)
Content	Diverse data formats (e.g., text, images, videos)	Primarily web pages, multimedia content, and hyperlinks

Table 2.1: comparison between the internet and the web

2.4 Web Architecture

The web architecture, also known as client-server architecture, forms the backbone of the World Wide Web (WWW). It is a distributed system composed of two main components: clients and servers. This section will delve into the intricacies of this architecture, providing a comprehensive analysis from a scientific perspective.

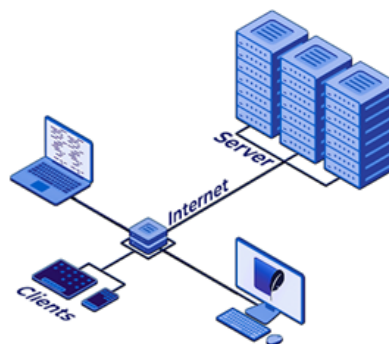


Figure 2.4: Client-server network diagram

2.4.1 Clients

Clients are entities that initiate requests for information or services and render web content from servers. These can be the user's devices such as computers, smartphones, tablets, and even specialized equipment like smart TVs. They typically employ web browsers, mobile applications, or other software to interact with the web. Clients are not connected directly to Internet, they get connected to it through their ISP (Internet Service Provider).

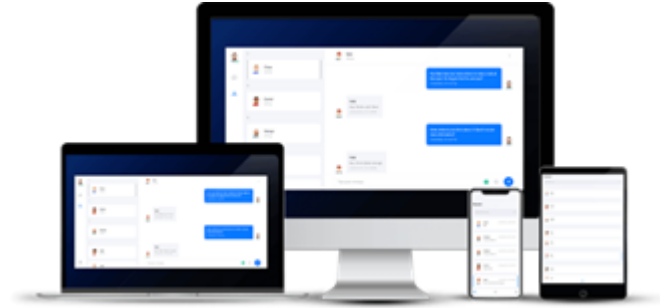


Figure 2.5: Different types of clients

2.4.1.1 Client Functionality

Clients perform various functions, including:

- **Requesting resources:** Clients send requests to servers for specific resources, such as web pages, images, videos, or data files.
- **Rendering content:** Clients receive and interpret the requested resources, presenting them to the user in a visually appealing and interactive manner.
- **User interaction:** Clients facilitate user interaction with the web, allowing users to navigate between pages, submit forms, and engage with interactive elements.

2.4.1.2 Client-Side Technologies

Several technologies are employed on the client-side to achieve these functionalities. Some of the most prominent include:

- **HTML (HyperText Markup Language):** Defines the structure and content of web pages.
- **CSS (Cascading Style Sheets):** Styles the visual presentation of web pages, including layout, fonts, colors, and animations.

- **JavaScript:** Adds interactivity and dynamic behavior to web pages, enabling features like form validation, animations, and real-time updates.

2.4.2 Servers

Servers programs or systems that run on powerful computers that host and deliver web content, data, resources, or services to other computers, known as clients, over a network. They are typically connected directly to the internet and possess special software and hardware like network equipment and dedicated network access to handle high volumes of requests efficiently and the web pages (content) are stored on that server's hard drive.

There are different types of servers such as web servers, mail servers, and virtual servers. These specialize in specific types of data or specific processing capabilities. They're all involved in providing the content that you request or the services that you need to perform.



Figure 2.6: Server diagram

2.4.2.1 Server Functionality

Servers perform various functions, including:

- **Storing and managing resources:** Servers store web pages, images, videos, and other data files, making them accessible to clients upon request.
- **Processing requests:** Servers receive and process client requests, retrieving the appropriate resources and generating responses.

- **Security and access control:** Servers implement security measures to protect data and ensure authorized access to resources.

2.4.2.2 Server-Side Technologies

Several technologies are employed on the server-side to achieve these functionalities. Some of the most prominent include:

- **Web servers:** Software applications responsible for handling client requests and delivering web content. Popular examples include Apache, Nginx, and IIS.
- **Database management systems (DBMS):** Store and manage structured data, enabling efficient access and manipulation of information. Popular examples include MySQL, PostgreSQL, and Oracle Database.
- **Server-side scripting languages:** Allow for dynamic content generation and server-side processing. Popular examples include PHP, Python, and Ruby on Rails.

2.4.3 Client-Server Interaction

The client-server architecture dictates the interaction between clients and servers. Clients initiate requests for resources, and servers respond with the requested data or services. This interaction typically follows a request-response pattern:

1. **Client request:** The client sends a request to the server, specifying the desired resource and any relevant parameters.
2. **Client request:** The client sends a request to the server, specifying the desired resource and any relevant parameters.
3. **Server response:** The server sends a response back to the client, containing the requested resource or an error message if the request could not be fulfilled.
4. **Client rendering:** The client receives the response and interprets it, rendering the content on the user's device.

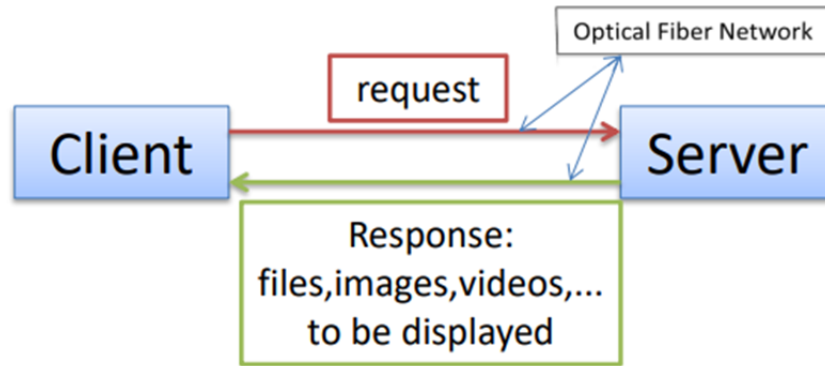


Figure 2.7: The basic web architecture “client-server architecture interaction”.

2.4.4 Advantages of Client-Server Architecture

The client-server architecture offers several advantages:

1. **Scalability:** The architecture can be easily scaled to accommodate increasing traffic and data demands by adding more servers.
2. **Flexibility:** Clients and servers can be developed and deployed independently, allowing for greater flexibility and customization.
3. **Security:** Servers can implement robust security measures to protect data and ensure authorized access.
4. **Cost-effectiveness:** Clients can be relatively inexpensive, while server costs can be optimized through resource allocation and load balancing.

2.4.5 How does the internet work?

First, the transfer of the data stored in the data center to the device is done via a complex network of optical fiber cable.

Optical fiber cables are always beneath the earth, they may go through hilly areas or under the seas.

There are few global companies who lay and maintain these optical cable networks like: ATT, Orange TM, Verizon and Google.

This complex optical cable network is the backbone of the internet.

These cables carrying the light are connected to:



Figure 2.8: Major players of submarine cable network

- **A router:** that converts the light signals to electrical signals, and then an Ethernet cable is used to transmit the electrical signal to a laptop.
- **A cell tower:** that converts the light into electromagnetic waves, and sends cellular data to cell phones.

These are the main steps of navigation a website:

1. Web assets and resources such as: HTML, CSS, JS, data files, images and videos are stored on a data center, more specifically on SSDs (Solid State Device) of a server.
2. A server is a powerful computer which stays on 24/7 to provide the assets and stored content whenever requested.
3. Any device that can be connected to the internet is given an IP address by its ISP (internet service provider). So phones, computers, servers, and tablets are identified uniquely by a string of numbers called an IP address. IP address acts like a shipping address through which all information reach their destination.
4. Any device can access any web site just by knowing the address of the servers.
5. It is difficult for a person to remember a series of numbers of many IP addresses, thus domain names like “google.com” and “youtube.com” are used instead of complex IP addresses, which are easier to remember.
6. The internet service provider uses and manages the DNS (Domain Name Server) to get the IP address corresponding to the domain name requests.

TO RECAP:

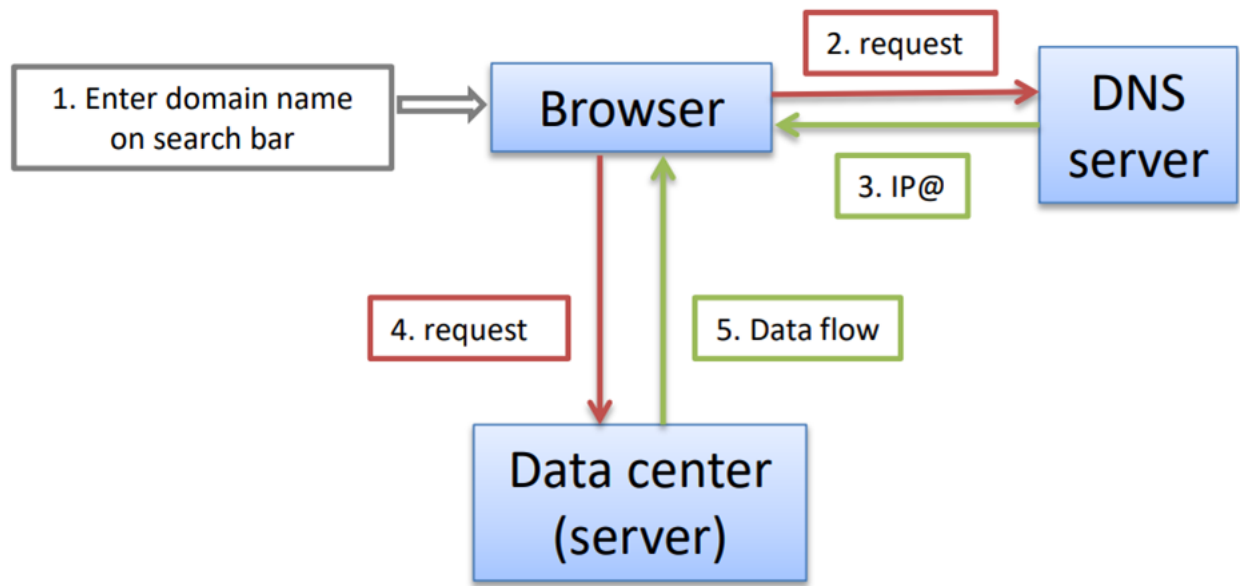


Figure 2.9: A simplified diagram of how a web browser works

2.5 Protocols

Network protocols are a set of rules, conventions, and data structures that dictate how devices exchange data across networks. They control all aspects of network communication from sending and receiving messages, to formatting files for different types of messages.

Similar to the way that speaking the same language simplifies communication between two people, network protocols make it possible for devices to interact with each other because of predetermined rules built into devices' software and hardware.

A network protocol will specify, for example:

- The format of data packets.
- The addressing system.
- Error-checking procedures used.

2.5.1 Internet Protocol

Our language is very different from the language that a computer uses. So the messages that we create need to be translated from an alphabetic text into an electronic signal before they can be sent. This translation is handled in the computer by the separate modules in the

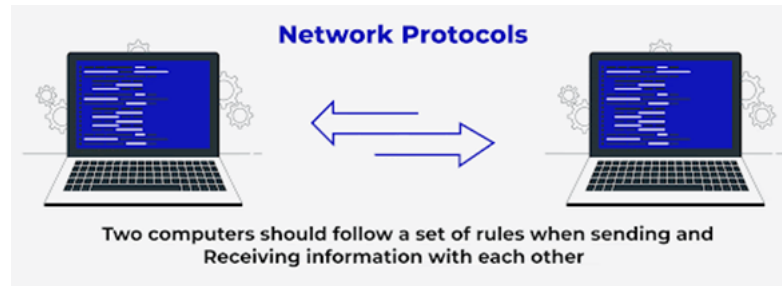


Figure 2.10: Network Protocol

communication protocol because these protocols or rules of conduct usually communicate with 2 or more modules. They are best described as layers in a stack of protocols. These layers in the TCP/IP (Transmission Control Protocol/Internet Protocol) model are: the application layer, transport layer, the internet layer, the link layer and the physical layer.

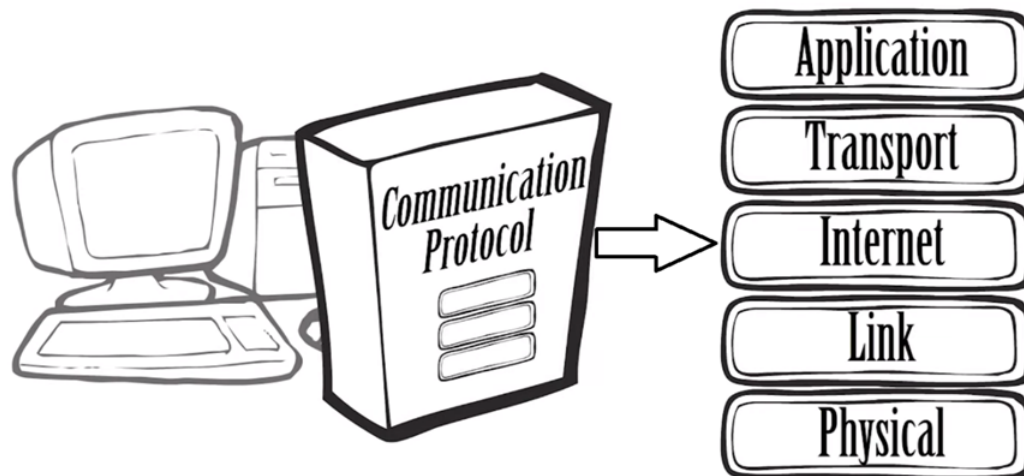


Figure 2.11: Internet protocol TCP/IP Model

The messages sent are filtered through these layers and broken down into small chunks of data called packets.

We start with **the application layer** to create our message. One example of a protocol from the application is the hypertext transfer protocol or http.

The transport layer uses the transmission control protocol or TCP to encapsulate the data blocks from the application layer, it then moves to **the internet layer** where the Internet Protocol or IP is used to deliver the packets.

These packets are delivered through **the link layer**, which is an Ethernet cable to **the physical layer**, which is the Basic Hardware of your computer network.

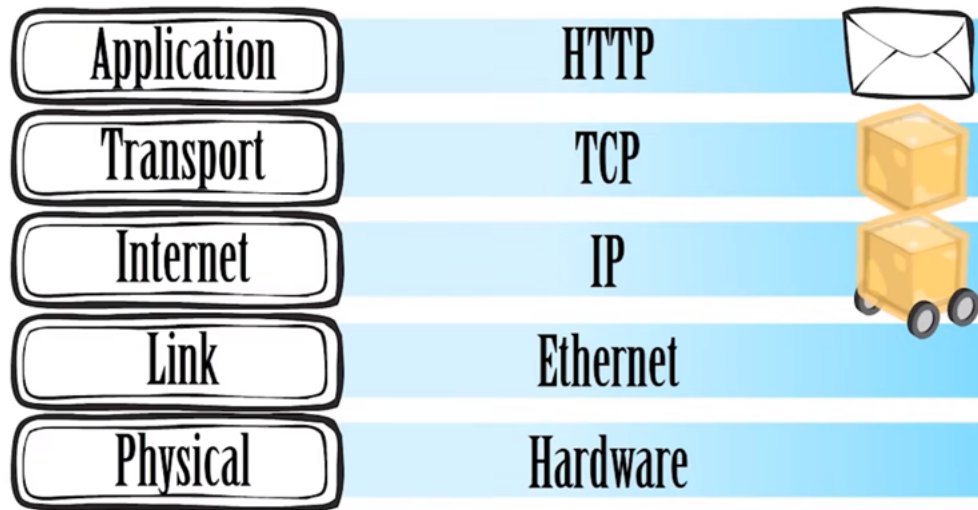


Figure 2.12: The protocol layers

The computer that receives these data packets moves them through the protocol stack in a reverse order so that the message can be reconstructed and understood.

2.5.2 Web protocol (HTTP Protocol)

HTTP stands for HyperText Transfer Protocol. HTTP is the underlying protocol used by the Web and this protocol defines how messages are formatted and transmitted. It also determines what actions Web servers and browsers should take in response to various commands.

For example, when you enter a URL in your browser, this sends an HTTP command to the Web server asking it to fetch and transmit the requested Web page.

The HTTP request contains different types of methods to pick out the desired action from the server. The most common methods are:

- **GET:** to retrieve data from the server.
- **POST:** to submit data to the server.
- **PUT:** to update data that's already on the server.
- **DELETE:** to delete data from the server.

This section has thoroughly introduced protocols, detailing their fundamental concepts, classifications, and applications. By examining the complexity of the TCP/IP model, the HTTP protocol, and other key protocols, we have gained a deeper understanding of the

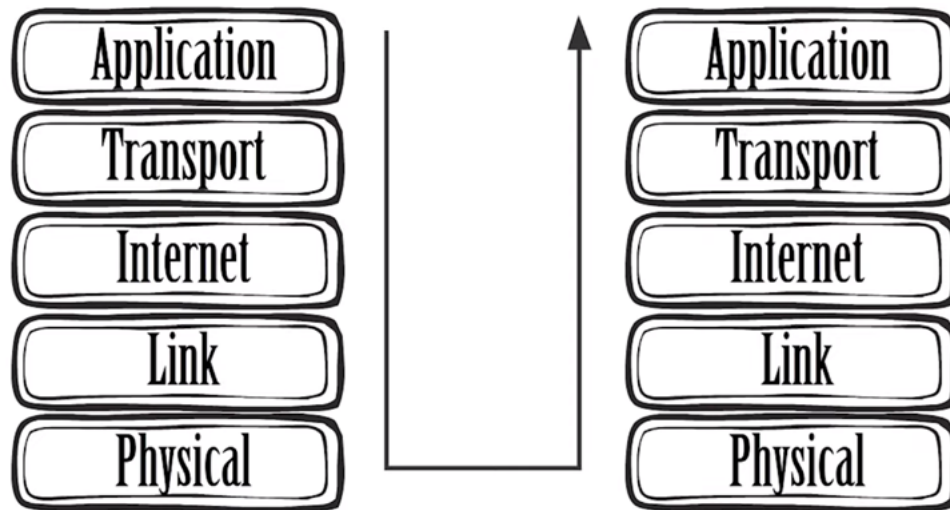


Figure 2.13: Construction of sent and received messages

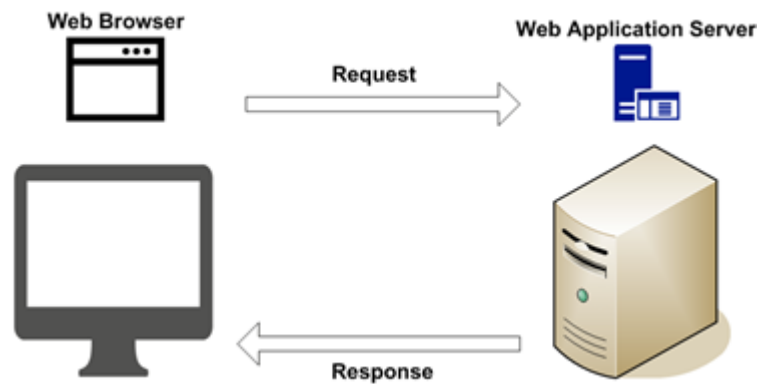


Figure 2.14: HTTP Client and Server model

complex components that drive our digital interactions. As we further explore the opportunities and address the challenges posed by these technologies, we can uphold protocols as the cornerstone of a secure, reliable, and inclusive digital future.

2.6 Web Development

Web development is the process of building websites and applications for the Internet or for a private network known as an Intranet.

Web development is not only concerned with the design of a website. It's also about the coding and programming that powers the website's functionality.

From the simplest, most static web pages to social media platforms and applications

and from E-commerce websites to content management systems (CMS) such as: WordPress, Joomla and Wix, all the tools we use daily via the Internet have been built by web developers.

Web development can be broken down into three layers:

- **Client-side coding (front-end):** refers to everything that the end user experiences directly. Client-side code is executed on a web browser and directly relates to what people see when they visit a website. Things like layout, fonts, colors, menus, and contact forms are all designed by the front-end.
- **Server-side coding (back-end):** is all about what goes on behind the scenes. The back-end is essentially the part of a website that the user don't see. It is responsible for storing and organizing data and ensuring that everything on the client-side runs smoothly. It does this by communicating with the front-end. Whenever something happens on the client-side, like a user fills out a form, the browser sends a request to the server-side. The server-side "responds" with relevant information in the form of front-end code that the browser can then interpret and display.
- **Database technology:** as explained in the above chapter.

By exploring both client-side and server-side coding, we have gained a comprehensive understanding of how dynamic and interactive web applications are built and maintained. The intricate dance between front-end and back-end technologies ensures that websites are not only visually appealing but also functional and efficient.

As we continue to innovate and adapt to new challenges in the digital landscape, the role of web development remains pivotal. The continuous evolution of web technologies promises to bring more sophisticated tools and frameworks, further enhancing the user experience and broadening the scope of what can be achieved online. By staying abreast of these advancements, developers can ensure they are building robust, secure, and scalable web applications that meet the needs of users and businesses alike.

In conclusion, web development is a field that merges creativity with technical expertise, playing a crucial role in shaping our digital world. As we look to the future, the principles and practices discussed in this chapter will remain foundational, guiding the development of innovative and impactful web solutions.

2.7 Conclusion

This chapter provides a comprehensive foundation in web development, exploring its fundamental concepts, technologies, and applications which are essential for anyone aiming to understand the intricacies of the World Wide Web. By outlining the differences between the internet and the web, and explaining the client-server architecture, the power of databases, we gain a profound appreciation for the ingenuity and dedication that reinforce the web experiences we enjoy today. This exploration has unveiled the fusion between front-end and back-end technologies, ensuring that websites are not only visually appealing but also functional and efficient. Moreover the detailed examination of protocols such as HTTP and TCP/IP protocols further deepens the understanding.

Mastery of these concepts is crucial for advanced studies in web technologies and for conducting meaningful research and shaping the future of communication, commerce, digitalization and information access.

Chapter 3

Implementation and realization

3.1 Introduction

In our end-of-study project, we want to design a platform for the management of patients' records in Algerian hospitals in addition to solving the storage and archives problems. In this chapter we will explain how our proposed solution; “MEDHUB” application works.

3.2 Application overview

Our application, called “MEDHUB” (THE FUTURE OF DIGITAL PATIENT RECORD MANAGEMENT), contains two areas; the secretary area which is responsible of the creation of the DPR and filling in the information related to the patient, and the doctor area which is responsible of uploading the medical images in different formats such as (jpg, png, gif, et bmp) writing reports and medical stays with the diagnosis. Our project is therefore a web-based application that allows the different users to manipulate the database across a set of interfaces.

3.3 Website specifications

Table 3.1: Web application specifications

Context	Background	The goal is to create an application/website for the nuclear medicine department, which is divided between CLCC CHU Chetouane Tlemcen and CHU Tlemcen. The goal is to create an application/website for the nuclear medicine department, which is divided between CLCC CHU Chetouane Tlemcen and CHU Tlemcen.
	Company Size (Hospital)	Doctors, ATM (radiology technicians, physicists...etc) biomedical engineers, and IT specialists.
	Activities	Products: Radiopharmaceuticals. Services: Consultation, treatment, and medical imaging examinations.
	Brand Positioning	Sensitive, confidential, health and medical imaging informatics
Project	Current State	Is this your first website? YES
	Objective of the first Site	• Create a pure Algerian tool specifically for medical informatics and hospital management and digitization. • Provide a pleasant mean of communication between doctors, administrators, and receptionists. • Reduce paper usage (paperless administration) and expedite the search for previous exams.

	Target	• CLCC CHU Tlemcen (initially targeting doctors) • Doctors need an application to facilitate their daily tasks, including: – Interpretation of exams (scintigraphy SPECT, CT-SPECT) – Writing reports – Displaying all previous exams and reports of the same patient (requiring a service database)
--	--------	---

Role	User Roles: • Doctors: Encrypted access to digital patient records (viewing and uploading images and reports) with the same access as the secretary. • Secretary: Limited access for entering new patients and their histories.	
------	--	--

Scope	Competitors	• The Moroccan product "Binarios": VisionRIS VisionPACS with remote user access • DEM
-------	-------------	---

Table 3.2:

Functional Description	Design	Content and Rendering	Images, photos, videos, and texts provided by you : • Medical images of patients • Previous reports Content that the developer must provide: • User-friendly interface • Fast data access • Well-organized platform • Visual Identity: – Platform colors (white, blue, black) – Clearly defined icons with their functions
		Examples of Preferences	• Aim for a site more advanced than DEM.
	Technical	Hosting	Who handles the site hosting and domain? • Initially hosted on a VPS (Virtual Private Server) for testing; later, for security and confidentiality, hosted on a local CHU server.
		Languages	Does the site need to be multilingual? • Primary language in French, with Arabic as a possible second language. Should the developer handle the translation? • YES, but we can cooperate.

Table 3.3:

		Technical Features	Does your site require specific functionalities involving programming? Yes, such as: • Members' areas • Internal search engine (searching patient names) • Automatic update management (by a doctor or a secretary) • Site update interface
		Site Up-date and Maintenance	Who will maintain the website? • Us • The developer through a specific contract.

Commitments and Deadlines	Schedule	We expect to receive our website after the month of April. We would like to plan intermediate steps to ensure the project is understood and on track.
	Deliverables	Ensure the developer provides: • A provisional schedule with the steps • The final site structure used • Programming files, graphics, databases,etc. • A document containing all technical information about the site: hosting, functionality. • Access credentials to the site.

3.4 Functionalities

1. Secretary Area:

- Encrypted access (ID + password)
- Window (Add patient) for entering digital patient information:
 1. Patient ID [must be unique*].
 2. File number [must be unique*].
 3. DPR number (digital patient record) [must be unique*].
 4. Name.
 5. First name.
 6. Gender (M/F).
 7. Marital status (married, single, widowed, divorced).
 8. Date of birth (displaying age).

9. Place of birth.
10. Profession.
11. Phone number (2 fields num1 and num2).
12. Address.
13. Entry date: (Date of patient record creation, auto-filled by the computer).
14. Exit date: (entered by the secretary)
15. Type of medical examination.
 - Consultation :
 - * Room:
 - * Bed number:
 - Medical imaging exam: exam modality entry (scintigraphy SPECT, etc. (text format))
16. Treating doctor's name (a list of all doctors should appear, and the DPR should be mentioned in the chosen doctor's space).
17. Treatment (medication) and previously done imaging exams (text format).
18. Patient search capability.
19. Sort patients by (alphabetical order, insertion date - today, this year).
20. For previous patients, an option to merge or add new data to the already created DPR (developer's choice).
 - Example of data to add:
 - (a) Entry date: (Date of patient record creation, auto-filled by the computer).
 - (b) Exit date: (entered by the secretary)
 - (c) Type of medical examination:
 - (d) Consultation:
 - Room:
 - Bed number:
 - (e) Medical imaging exam: exam modality entry (scintigraphy SPECT, CT, etc. (text format)).
 - (f) Treating doctor's name.
 - (g) Treatment (medication) and previously done imaging exams (text format).

2. Doctor Area:

1. Encrypted access (ID + password).
2. Access to the list of patient records created by the secretary with all entered information. (display by records created today)
3. Window (previous exams) for viewing all images previously done by the patient in the service. [Window divided between image display and patient list]
4. Observation (text format).
5. Additional explorations.
6. Discharge status.
7. Icon (add exam) for uploading a new exam/image.
8. Patient search capability.
9. Sort patients by (alphabetical order, insertion date - today, this week, this month, this year, type of medical examination).
10. Ability to write reports on the site with the same properties as Microsoft Word and the option to print.

3.5 Development Tools and Technologies

Here are the different programming languages, frameworks, database system and the development environment used to realize our web application.

Table 3.4: The platform's developing environment

The platform's developing environment	
Microsoft Visual Studio Code	Also known as "Microsoft VS Code", which is a popular, open-source Code Editor/Integrated Development Environment (IDE) developed by Microsoft. It provides support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git. It is highly customizable, allowing users to change the theme, keyboard shortcuts, and preferences, and to install extensions that add functionality. Visual Studio Code is used by developers for writing and editing code in a variety of programming languages.

Table 3.5: Front-end technologies

Language	Definition
Html 5	HTML5 (HyperText Markup Language version 5) is the standardized web language used to structure the content of web pages. It provides the basic elements for defining titles, paragraphs, links, images, forms and other essential elements of a web page.
CSS 3	CSS3 (Cascading Style Sheets version 3) est un langage complémentaire à HTML5 qui permet de styliser l'apparence des pages web. Il contrôle la mise en page, les couleurs, les polices de caractères, les animations et bien plus encore, transformant le squelette HTML en une expérience visuelle riche et interactive.
Javascript	JavaScript (often abbreviated as JS) is a high-level, interpreted programming language that plays a critical role in creating dynamic and interactive web pages. It's considered one of the three core technologies alongside HTML and CSS that form the foundation of most websites.

Table 3.6: Back-end technologies

Framework	Definition
Laravel 10	Laravel is a popular open-source framework for web development in PHP, known for its elegant, expressive syntax and robust approach to building modern web applications. The latest major version, Laravel 10, was released in February 2024 and brings a set of new features and improvements to simplify and optimize web development.
Livewire 3	Livewire 3 is a complementary framework for Laravel that allows you to create dynamic and reactive web interfaces without leaving the Laravel environment. In other words, it saves you from having to write heavy JavaScript code to manage the user interface updates of your application.
PHP 8.3	PHP 8.3, released in November 2023, is a major update to the popular open-source general-purpose scripting language widely used for server-side web development. It introduces several new features, improvements, and changes designed to enhance developer experience, performance, and code readability

Table 3.7: Database software

Database software	
mysql	MySQL is a popular open-source relational database management system (RDBMS). It excels at storing, organizing and managing structured data in a way that facilitates its efficient retrieval and manipulation.

3.6 Presentation of the interfaces

3.6.1 Landing page

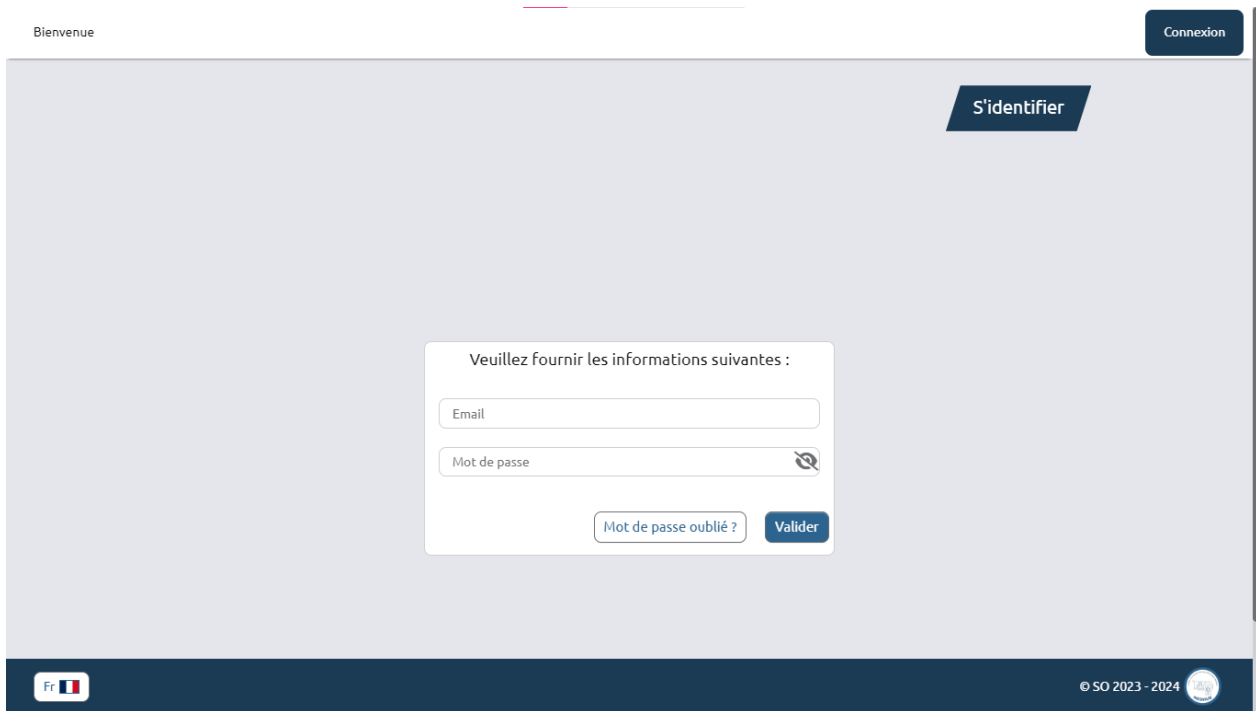
Contains the application's logo, name and slogan. When clicking on “connexion” button we move to the ‘login page’.



Figure 3.1: Landing page

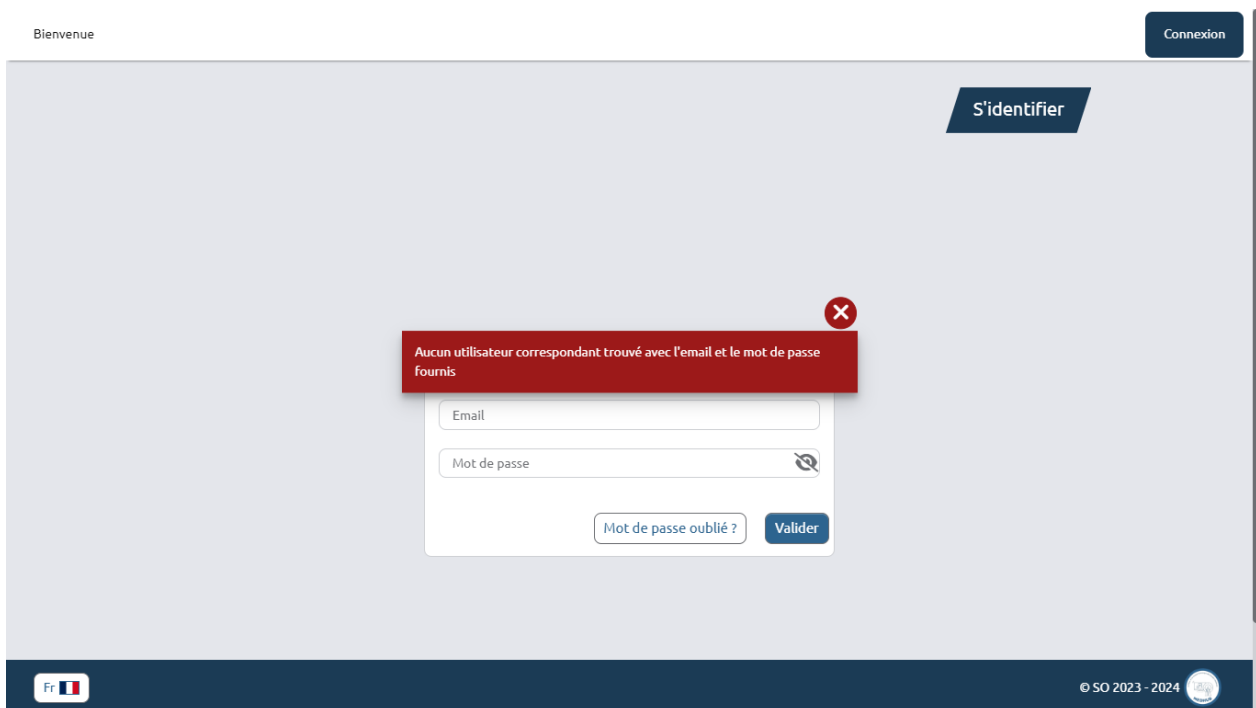
3.6.2 Login Interface

Our application receives users via a login page with two fields, the first for email and the other for password. If incorrect email or password are entered, the application will display a message of error.



The screenshot shows a login page with a light gray background. At the top left, the word "Bienvenue" is displayed. At the top right, there is a dark blue button labeled "Connexion". Below this, on the right side, is a dark blue button labeled "S'identifier". In the center, there is a white form box with the title "Veuillez fournir les informations suivantes :". Inside the form, there are two input fields: "Email" and "Mot de passe". The "Mot de passe" field has a toggle icon to its right. Below the "Mot de passe" field, there is a link "Mot de passe oublié ?" and a dark blue button labeled "Valider". At the bottom left, there is a small French flag icon and the text "Fr". At the bottom right, there is a copyright notice "© SO 2023 - 2024" and a small circular logo.

Figure 3.2: Login page



The screenshot shows the same login page as Figure 3.2, but with an error message displayed. The error message is a red box with a white "X" icon in the top right corner. The text inside the box reads: "Aucun utilisateur correspondant trouvé avec l'email et le mot de passe fournis". The form fields and buttons are still visible and functional.

Figure 3.3: Error message displayed for incorrect email or password

3.6.3 User interface

This interface appears to all users. The medical secretary can add and identify patients who have medical visits that day and access their records to modify if needed in addition to diverse search bars for any patient in the data base.

Espace Utilisateur

super Admin

Espace Utilisateur

Ajouter un patient

Recherche de patients :

Nom en français

Prénom en français

Code Patient

Nom en arabe

Prénom en arabe

Date de naissance
jj/mm/aaaa

Email

Nom du Médecin traitant

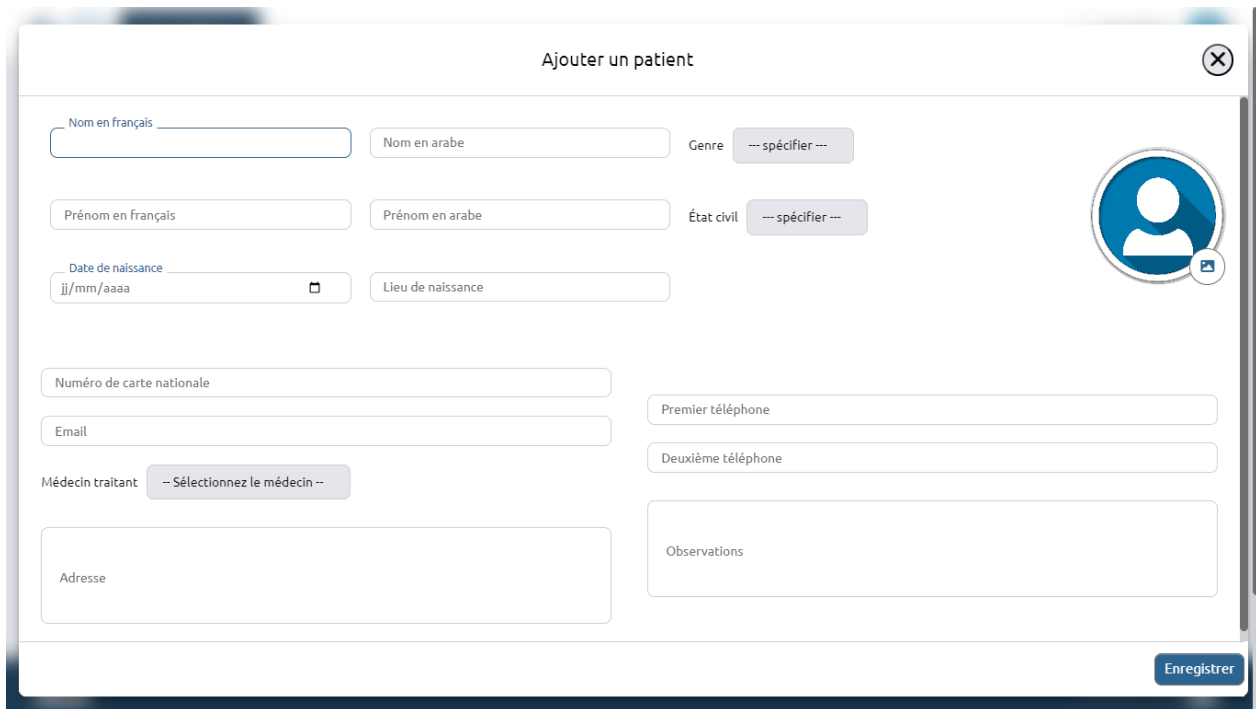
CODE PATIENT	NOM EN FRANÇAIS	PRÉNOM EN FRANÇAIS	NOM EN ARABE	PRÉNOM EN ARABE	NOM DU MÉDECIN TRAITANT
240500001F	Zoukel	Samia	زوكل	سامية	messadia
240600001F	MESSADIA	Dima	مسادية	ديمية	messadia
240600002F	YAICH ACHOUR	ZINEB	يعيش االشور	زينب	super Admin
240600003M	BENAMAR	AEK	بن عمر	عبد القادر	si kaddour

Fr

© SO 2023 - 2024

Figure 3.4: User interface

The secretary creates a new patient record by entering all his information, the treating doctor and in the observations area he mentions the assessments or the pre-examinations already done by the patient.



The screenshot shows a web form titled "Ajouter un patient" with a close button (X) in the top right corner. The form is organized into several sections. The top section contains input fields for "Nom en français", "Nom en arabe", "Genre" (with a dropdown menu showing "--- spécifier ---"), "Prénom en français", "Prénom en arabe", and "État civil" (also with a dropdown menu). Below these is a "Date de naissance" field with a date picker icon and a "Lieu de naissance" field. The middle section includes a "Numéro de carte nationale" field, an "Email" field, and a "Premier téléphone" field. The bottom section features a "Médecin traitant" dropdown menu with the text "-- Sélectionnez le médecin --", a "Deuxième téléphone" field, and a large "Observations" text area. At the bottom right, there is an "Adresse" field and an "Enregistrer" button. A circular profile icon with a blue background and a white silhouette is located on the right side of the form.

Figure 3.5: Creation of a DPR

3.6.4 User's management interface

Only Admins have the access to the users' management interface it contains the list of all the users that have been given access to the platform, in addition to adding and removing users and giving them different roles.

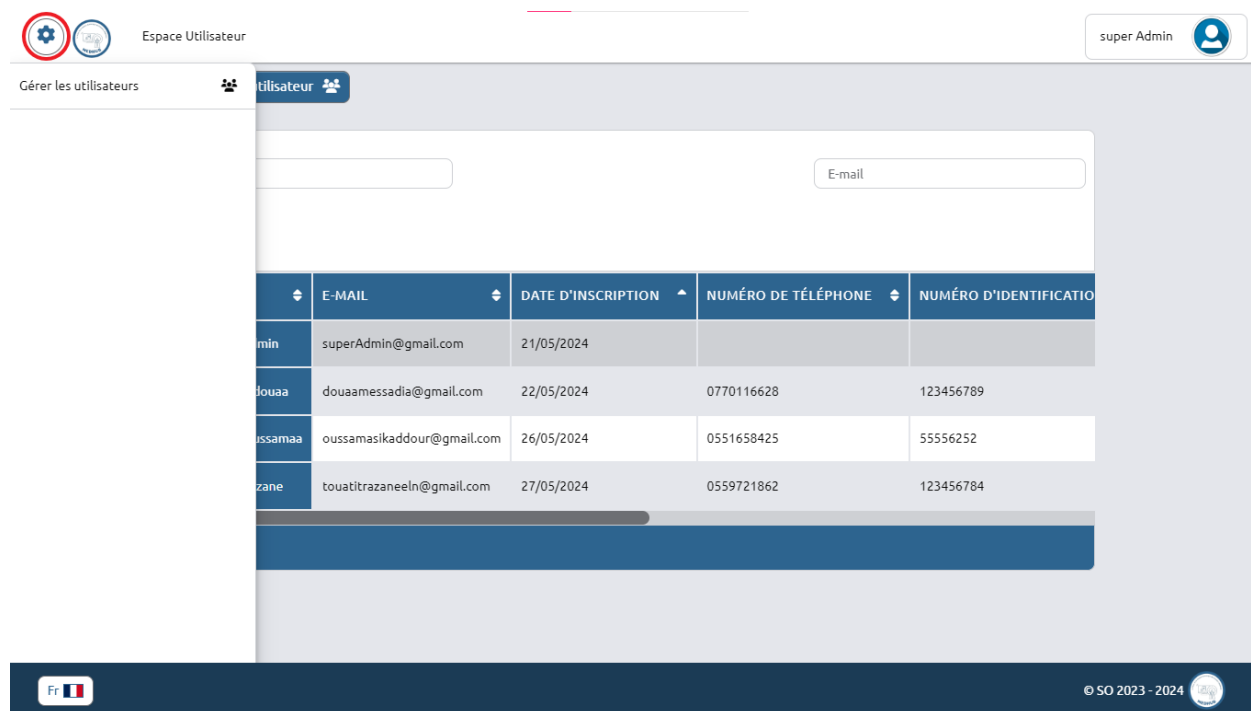


Figure 3.6: User's management interface

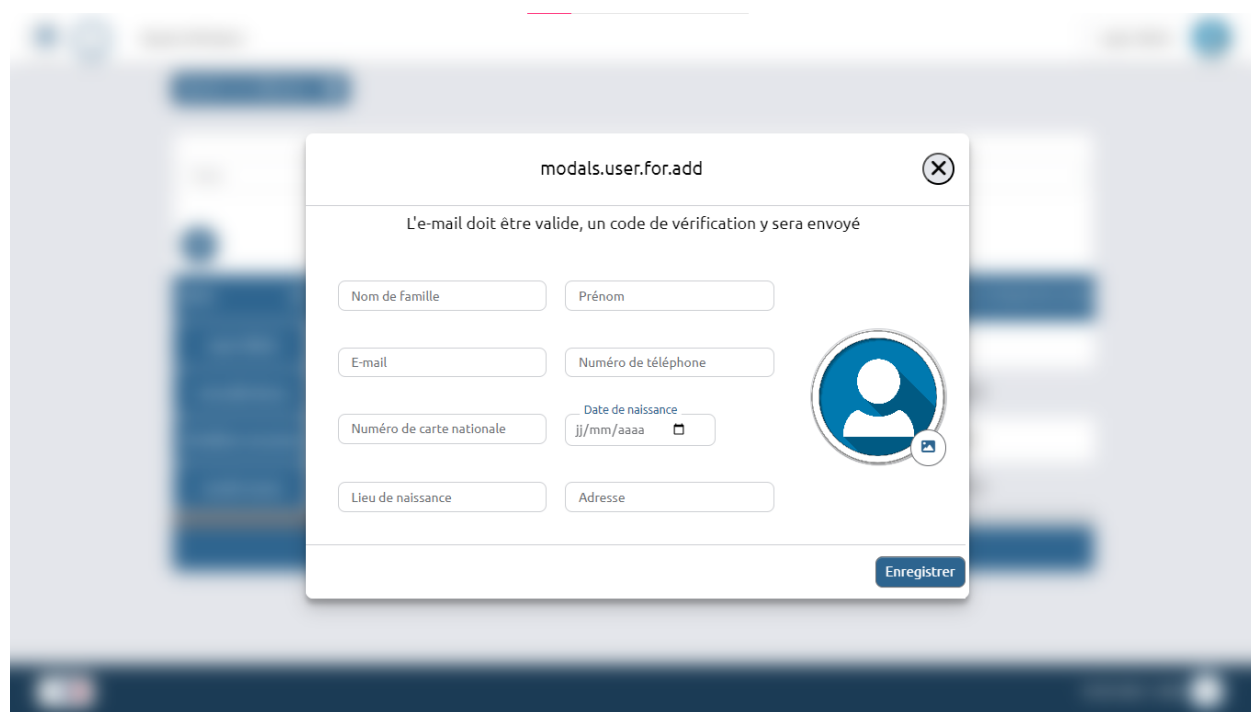


Figure 3.7: Adding a new user to the platform

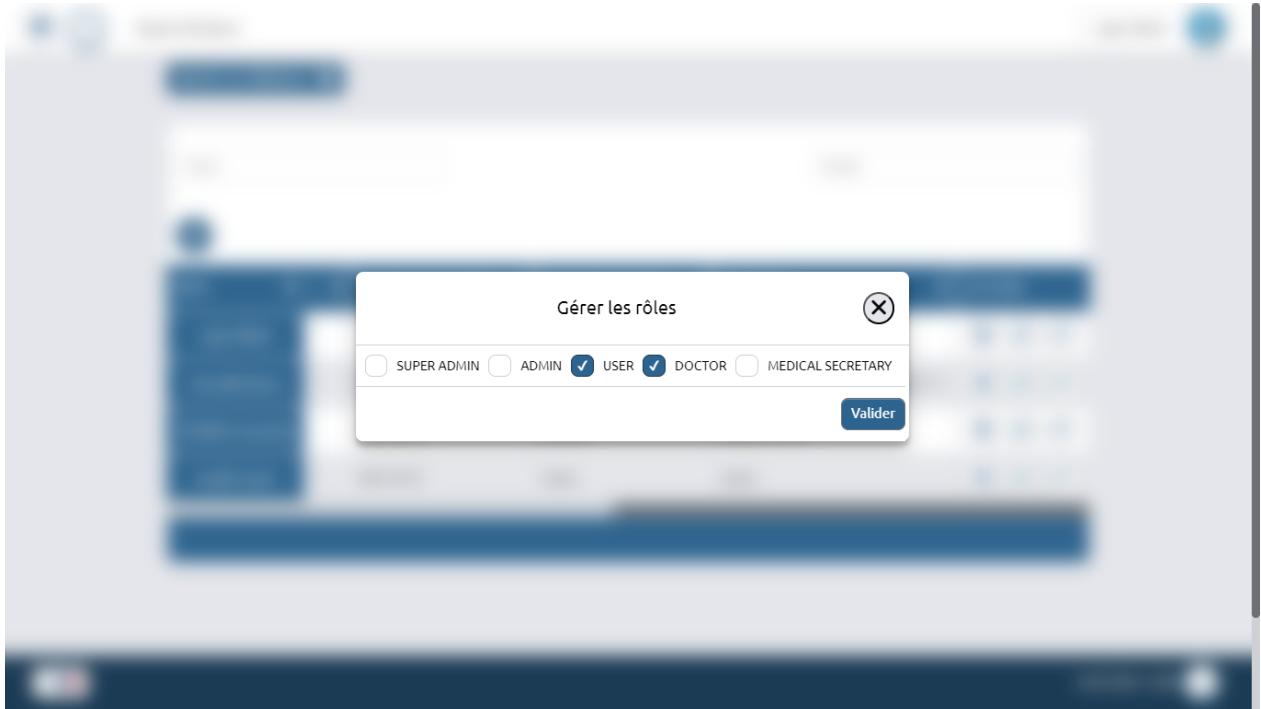


Figure 3.8: Different roles existing on the platform checked only by the admin

3.6.5 Doctor Interface

The doctor area has an additional eye icon in the users' interface through which the doctor can access the medical images, reports, and diagnosis or even create new ones.

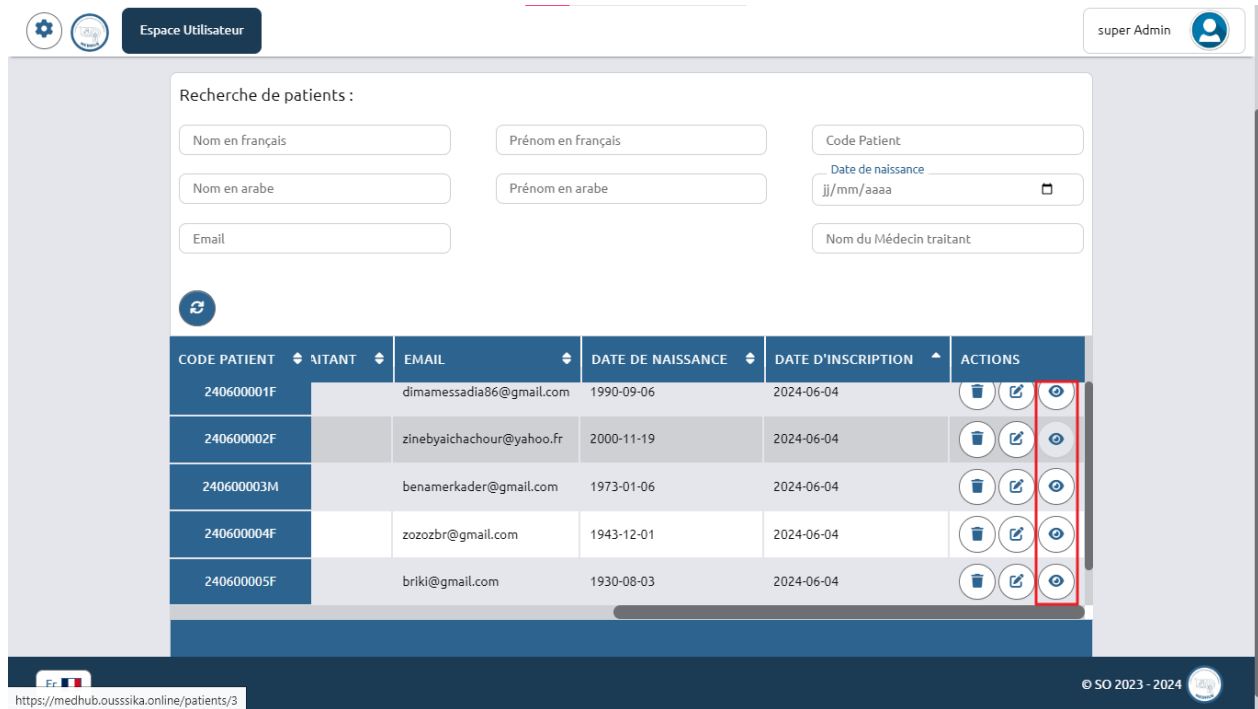


Figure 3.9: View Patient record icon

3.6.6 Patient Record Interface

This page contains:

1. Medical stays of the patient.
2. Radiological examinations.
3. Printing option of both files above.

With researching bars of all previous Medical consultation done at the unit.

The interface displays patient information for **240600002F YAICH ACHOUR ZINEB**. It includes two checkboxes: **Inclure les examens radiologiques** and **Inclure les séjours médicaux**, with a red circle and arrow pointing to a print icon labeled **3. Printing option of both files above.**

Below this is a section for **Ajouter un séjour médical**, highlighted with a red box and labeled **1. Medical stays of the patient.** This section contains input fields for **Date d'entrée** (jj/mm/aaaa), **Date de sortie** (jj/mm/aaaa), **Mode d'entrée**, **Chambre**, **Mode de sortie**, and a table of medical stays.

MODE D'ENTRÉE	DATE D'ENTRÉE	CHAMBRE	MODE DE SORTIE	DATE DE SORTIE	ACTIONS
normale	2024-06-08	1			[Icones]

Below the table is a section for **Ajouter un examen radiologique**, highlighted with a red box and labeled **2. Radiological examinations.** This section contains input fields for **Nom du docteur**, **Date de début** (jj/mm/aaaa), **Date de fin** (jj/mm/aaaa), and a dropdown for **Type d'examen** (--- Sélectionnez le type ---). Below this is a table of radiological examinations.

TYPE D'EXAMEN	NOM DU DOCTEUR	DATE DE L'EXAMEN	ACTIONS
Tomographie par émission de positons (TEP)	messadia douaa	2024-06-08	[Icones]

The footer shows the French flag, the text **© SO 2023 - 2024**, and a logo.

Figure 3.10: Patient Record Interface

1. Medical stays of the patient page contains: date of entry and discharge, admission and discharge mode, room number, bed number and diagnosis.

The screenshot shows a web application interface for updating a medical stay. The title is "Mettre à jour le séjour médical". The form is divided into several sections:

- Header:** "Date d'entrée" (08/06/2024) and "Mode d'entrée" (normale).
- Room and Bed:** "Chambre" (1) and "Lit" (2).
- Discharge Information:** "Date de sortie" (20/06/2024) and "Mode de sortie".
- Diagnostic Section:** A rich text editor with a toolbar. It contains a "Differential Diagnosis List" with the text: "These findings are consistent with an admixture of predominantly viable and some non-viable tissue. The remainder of the heart reveals normal perfusion and oxidative metabolism, consistent with viable myocardium. It is likely that systolic function will improve following coronary artery revascularization."
- État de sortie (Discharge Status):** A rich text editor with a toolbar.
- Indication donnée (Given Indication):** A rich text editor with a toolbar.

Each rich text editor is built with "tinymce". There is a "Enregistrer" (Save) button at the bottom right.

Figure 3.11: Medical stays of the patient.

2. Radiological examinations section contains: the selection of the radiological examinations type at the nuclear medecin unit, in addition to creation or modification of the medical report and deleting the exam .

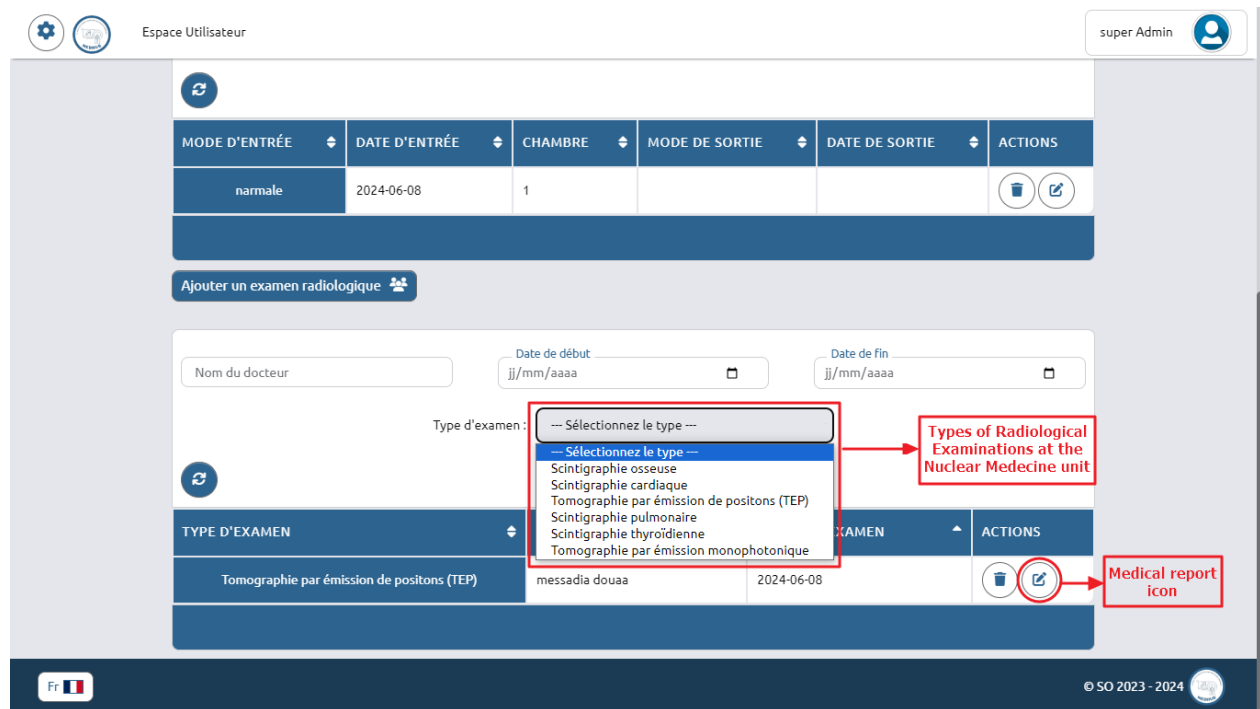


Figure 3.12: Radiological examinations section

The medical report icon leads to a page where the doctor can write the report and upload the medical images.

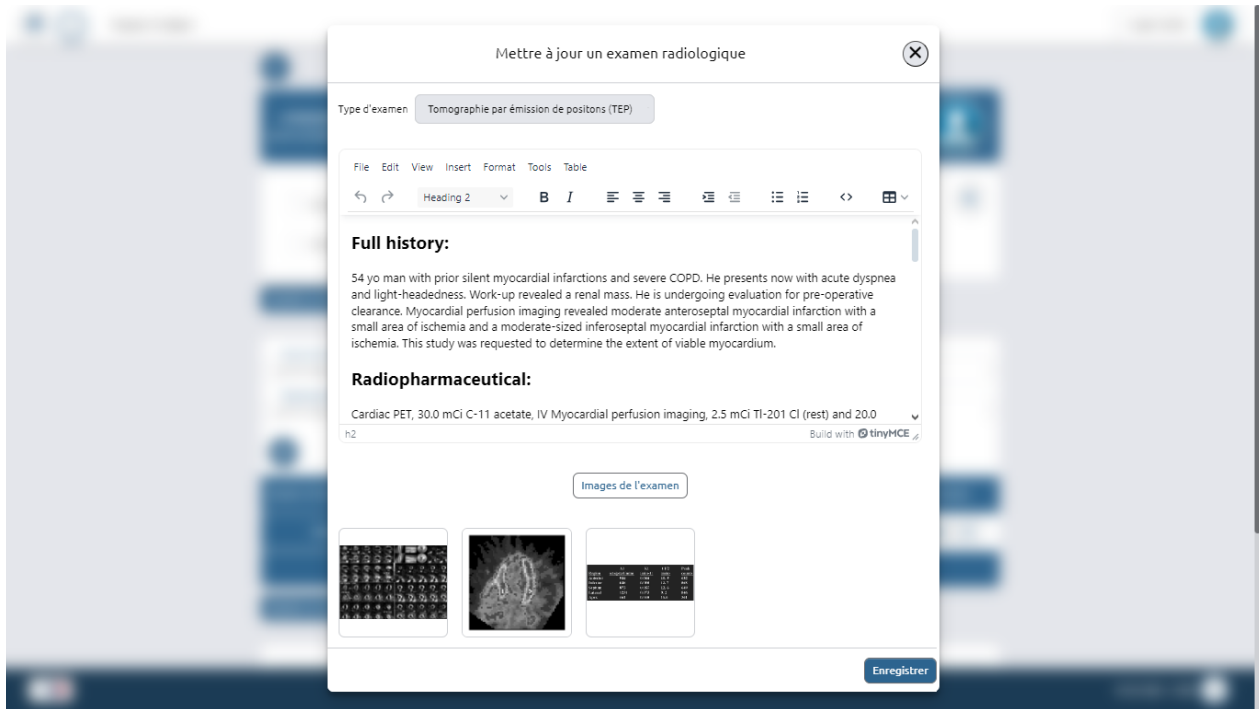


Figure 3.13: Medical report page

3. Printing option of both files above: it's on the top of the page, the doctor need to check the desired files to print and mention the date of the examination if he wants to print it specifically; if not mentioned, all the examinations will be added automatically to the pdf file which will be printed after.

The pdf file is generated with a predefined heading mentioning the hospital's and the service's name, in addition to, the full name, code, birthday date, date of the examination, type of the radiological exam, written report and uploaded medical images then the section of the medical stay if checked, all generated automatically from the inserted information by both the secretary and the doctor.

**CENTRE HOSPITALO-UNIVERSITAIRE Dr DAMERDJI TLEMCEEN
SERVICE DE MEDECINE NUCLEAIRE
Chef de service Dr MEDJAHEDI**

Nom: ZOUBIRI ZOHRA
Code: 240600004F
DDN: 1943-12-01

Examens Radiologiques

Date d'examen: 2024-06-08
Type: Scintigraphie pulmonaire

Diagnosis: MAA injection while on ECMO

Full history:

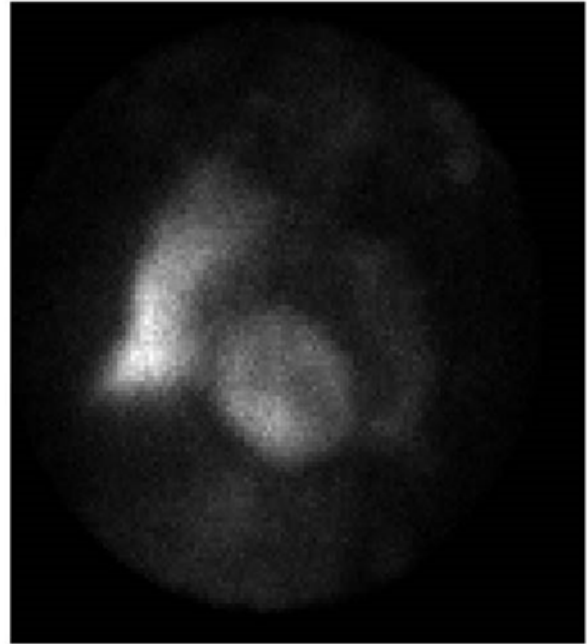
81-year old woman who previously underwent bilateral pulmonary transplantation and repair of a ventriculoseptal defect. The patient is currently on extracorporeal membrane oxygenation (ECMO) and is referred for evaluation of pulmonary perfusion.

Findings:

The initial image demonstrates uptake in the myocardium. The reason for this is that the patient was on ECMO during the injection of Tc-99m MAA. During ECMO blood is removed from the right atrium and sent through the ECMO chamber for oxygenation and then returned to the aortic root. Because of this, the Tc-99m MAA was also shunted directly from the right atrium to the aortic root with subsequent deposition in the myocardium. This problem was immediately recognized. Subsequently, the ECMO was turned off momentarily while a second dose of Tc-99m MAA was administered intravenously with resultant deposition in the pulmonary vascular bed as had been initially desired. Evaluation of pulmonary perfusion demonstrated asymmetry with the right lung receiving 94% and the left lung 6% of the total pulmonary perfusion.

Followup:

The patient is currently under the care of the critical care team. Plans have been made for in-service training regarding ECMO for the nuclear medicine technical staff.



Major teaching point(s):

It is important when evaluating any patient who is on ECMO to understand the basics about ECMO and how it may effect the uptake of any radiopharmaceutical. In this case, the injection which was made while ECMO was operating resulted in significant uptake in the myocardium, with essentially no uptake in the pulmonary vascular bed. The injection made after ECMO was turned off resulted in deposition in the pulmonary bed, as was desired.

Figure 3.14: The PDF file to be printed

General conclusion

The transition towards a digital healthcare ecosystem is not just a trend but a necessity in modern medical practice. This project, inspired by the challenges observed at the CHU Tlemcen, aims to address critical issues related to paper-based medical records, which create inefficiencies in data management, storage problems, and the fragmentation of medical records. By implementing a web-based electronic medical records (DPR) management platform, we strive to create a seamless, paperless environment that enhances data accessibility, improves the continuity and quality of care, and ensures the security of patient information.

MedHub, our proposed platform, integrates the fields of web development and medical imaging informatics to provide a comprehensive solution tailored to the specific needs of Algerian hospitals. This platform creates a centralized, paperless environment, promising to revolutionize how patient data is handled. It allows for real-time access to complete medical histories, which in turn facilitates more informed and timely medical decisions.

Looking ahead, we envision MedHub evolving to incorporate advanced digital technologies such as cloud computing and cybersecurity measures. These will ensure the confidentiality and integrity of sensitive medical information, provide predictive analytics aiding in early diagnosis and personalized treatment plans by integrating artificial intelligence (AI). We also aim to scale MedHub to other hospitals and healthcare facilities across Algeria, ensuring a standardized and efficient approach to medical records management and the ability to exchange and transfer DPRs between different hospitals, units, and doctors.

This digital transformation will not only improve operational efficiency but also support the broader agenda of digital literacy. Valuable insights derived from patient data would help in analytics and statistics across multiple factors (regions, diseases, gender, age, socioeconomic status, etc.) and in conducting research and innovation within the Algerian healthcare sector.

Ultimately, the successful implementation of this project will signify a major leap forward in the quality of healthcare delivery in Algeria. It will empower healthcare professionals with the tools they need to provide better care, thus enhancing the overall resilience and

responsiveness of the healthcare system. This project sets the stage for a more connected, data-driven, and patient-centric future, contributing significantly to the well-being and prosperity of Algerian citizens.

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Appendix A

Business Model Canvas BMC



REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique

Université Abou Bekr Belkaid Tlemcen

Business Model Canvas

BMC

Date de dépôt :

N° de projet : FT-068

Faculté/Institut : Technologie

Département : Génie Biomédical

Nom du projet : Development of a Web Application for Digital Patient Record Management

Encadrant 1 : Prof. FEROUJ Amel

Co-encadrant 1 : SIKADDOUR Oussama

Etudiants :

- MESSADIA Doua
- TOUATIT Razane

Année universitaire : 2023/2024

1- Proposition de valeur (Value Proposition) القيمة المقترحة

a. Quels problèmes résolvons-nous pour nos clients ?

ما هي المشاكل التي نحلها لعملائنا ؟

- Fournir une plateforme facile à utiliser pour la création du dossier patient numérique.
- Réduction de feuilles utilisées : la plus part des administrations algériennes se base sur la paperasse surtout dans le secteur médical, d'où l'intérêt des dossiers patient numériques ou tous va être archivés numériquement ce qui apportera des impacts écologiques et économiques.
- Réduction du temps passé dans la recherche des dossiers patients archivés.
- Facilité d'accès aux antécédents du patient dans un seul clique sans avoir besoin de feuilleter les comptes rendus, les images des examens radiologiques et scintigraphiques, les séjours médicales, les médicaments prescrit et les diagnostics déjà faites manuellement.

b. Quels besoins de nos clients satisfont nos produits ou services ?

ما هي الاحتياجات التي يلبىها منتجاتنا أو خدماتنا لعملائنا ؟

- Une seule fenêtre contient : Téléchargement et archivage des images dans la plateforme, Rédaction des comptes rendus, ajout des séjours médicaux avec le diagnostic et impression de toutes les informations introduites, avec la possibilité de trier et sélectionner quoi à imprimer.

c. En quoi notre offre est-elle différente de celle de nos concurrents ?

في ماذا تختلف عروضنا عن تلك التي يقدمها منافسوننا ؟

- Notre service est Algérien qui marche tres bien avec les besoins et la mentalité Algériennes.

2- Segments de clients (Customer Segment) : أنواع العملاء

- a. Quels sont nos clients principaux ?

من هم العملاء او الزبائن الرئيسيون ؟

Les clients principaux sont les médecins spécialistes en radiologie et en médecine nucléaire et les manipulateurs en radiologie.

- b. Quels sont les différents segments de clients que nous visons ?

ما هي الفئات المختلفة من العملاء التي تستهدفها؟

Les différents clients sont les hôpitaux et les cliniques publiques et privées, les centres de lutte contre le cancer (CLCCs), les centres hospitalo-universitaires (CHUs).

- c. Quels sont les besoins spécifiques de chaque segment de clients ?

ما هي الاحتياجات الخاصة لكل فئة من العملاء؟

Les besoins spécifiques sont :

- la sécurité
- Rapidité
- La qualité
- Plus économique
- À moindre coût

- d. Comment pouvons-nous catégoriser nos clients en groupes distincts ?

كيف يمكن تصنيف عملائنا الى مجموعات مختلفة؟

Nos clients peuvent se catégoriser en deux groupes distincts :

- Les individus : ce sont des médecins indépendants qui ont leurs centres ou cabinets privés.
- Etablissement de santé : Les cliniques, hôpitaux, CLCC (Centres de Lutte Contre le Cancer), et CHU (Centres Hospitaliers Universitaires)

3- Relation avec les clients (Consumer Relationships) علاقة مع العملاء :

- a. Quel type de relation chaque segment de clients attend il de nous ?
اي نوع من العلاقة يتوقعه كل فئة من العملاء منا؟
- Une relation de bouche à l'oreille ou nous déplaçons vers l'intéressé pour lui offrir notre service et lui faire expliquer le fonctionnement de notre plateforme.
 - Une relation par les expositions et les foires nationales et internationales comme (ImLab et SIMEM... etc) où les intéressés se déplacent pour chercher ce qu'ils ont besoin.
 - Via publicités sur les réseaux sociaux.
 - Une relation en ligne où le client nous contacte et demande l'accès à notre plateforme à distance sans déplacement ou rencontre.
- b. Comment entretenons-nous actuellement les relations avec nos clients ?
كيف نحافظ حاليًا على العلاقات مع عملائنا؟
- Par des promotions spéciales pour les clients fidèles.
 - Par des mises à jour fréquentes dans la plateforme.
 - En ajoutant des options et plus de fonctionnalités.
- c. Comment pouvons-nous améliorer ou personnaliser nos interactions avec nos clients ?
كيف يمكننا تحسين أو تخصيص تفاعلاتنا مع عملائنا؟
- En restant toujours à leur écoute et à leur disposition en cas de panne ou de dysfonctionnement.
 - En prenant en considération les critiques.
 - En améliorant la plateforme selon leurs besoins spécifiques.

4-Canaux de distribution (Channels) قنوات التوزيع :

- a- Par quels canaux nos clients veulent-ils être atteints ?

من خلال أي قنوات يفضل عملاؤنا أن يتم التواصل معهم؟

Le canal le plus fréquent est de se déplacer chez le client pour installer le service et lui montrer le mode de fonctionnement.

- b- Quels canaux sont les plus efficaces pour atteindre chaque segment de clients ?

ما هي القنوات الأكثر فعالية للوصول إلى كل فئة من العملاء؟

Nos clients peuvent également préférer être atteints par téléphone, email, support en ligne, ou via des réunions virtuelles pour plus de flexibilité et de commodité.

- c- Comment pouvons-nous intégrer différents canaux pour améliorer l'expérience clients ?

كيف يمكننا دمج مختلف القنوات لتحسين تجربة العملاء؟

Pour améliorer l'expérience client, nous pouvons proposer deux méthodes de paiement : en espèces ou par carte de crédit qui permet aux clients de payer facilement leurs services et produits.

5-Partenaires clés (Key Partnerships) : الشراكة الرئيسية :

a. Qui sont nos partenaires clés ?

من هم شركاؤنا الرئيسيون؟

- Ingénieurs en informatique.
- Ingénieurs en logiciel
- Experts en marketing
- Experts en cyber Security

b. Quels sont les partenariats qui nous aident à réduire les coûts, à accéder à de nouvelles ressources ou à améliorer notre proposition de valeur ?

ما هي الشراكات التي تساعدنا على خفض التكاليف أو الوصول إلى موارد جديدة أو تحسين قيمتنا المقترحة؟

Puisque le projet est basé purement sur le web, on peut travailler en collaboration avec les entreprises Tech et de développement logiciel qui offrent différents services selon le besoin de notre projet donc le revenu sera divisé entre nous.

6-Activités clés (Key Activities): الأنشطة الرئيسية:

- a. Quelles sont les actions principales que nous devons entreprendre pour livrer notre proposition de valeur ?

ما هي الأنشطة الرئيسية التي يجب علينا القيام بها لتقديم قيمتنا المقترحة؟

- Développement web
- Renforcer le cyber Security
- Adopter un Design ergonomique
- Collaborer avec des consultants en marketing et marketing digital
- Collaborer avec Ministère de santé

- b. Quelles sont les opérations essentielles pour notre entreprise ?

ما هي العمليات الأساسية لشركتنا؟

L'opération essentielle de notre entreprise est l'informatique de l'imagerie médicale, autrement dit nous nous intéressons de la numérisation du secteur de santé et de tous ce qui a une relation avec les services d'imagerie médical et la création des dossiers patients numériques. Nous utilisons le développement web pour la réalisation du notre plateforme de projet.

- c. Quelles sont les activités qui créent le plus de valeur pour nos clients ?

ما هي الأنشطة التي تخلق أكبر قيمة لعملائنا؟

Si nous obtiendrons un soutien gouvernemental par le ministère de la santé notre projet peut être applicable dans tous les hôpitaux du secteur public sans aucun gêne alors la qualité de soins fournie aux patients s'améliore.

7- Ressources clés (Key resources): الموارد الرئيسية:

a. Quels sont nos actifs matériels, immatériels et humains essentiels ?

ما هي الأصول المادية وغير المادية والبشرية الأساسية لدينا؟

- Médecins spécialistes en radiologie et en médecine nucléaire
- Hôpitaux publics et privés
- Cliniques
- Centre d'imagerie médicale

b. Quels sont les principaux avantages concurrentiels de nos ressources ?

ما هي المزايا التنافسية الرئيسية لمواردنا؟

Le domaine médical et ses technologies s'évaluent constamment donc nous voulons améliorer le quotidien de nos médecins, qui sont familier et au courant des produits et les services étrangers, par notre plateforme qui est développée en répondant à leurs demandes et en tenant compte des problèmes et des lacunes qu'ils rencontrent.

8- Charges et coûts (Coste structure) :التكاليف:

- a. Quels sont les coûts fixes et variables associés à notre modèle économique ?
ما هي التكاليف الثابتة والمتغيرة المرتبطة بنموذجنا الاقتصادي؟

Les coûts fixes :

- Ordinateur (écran, unité, souris, clavier)
- Télévision,
- Equipements de bureau (tables et chaises ...etc)
- Data show

Les coûts variables :

- Coûts d'hébergement VPS
- Abonnement internet
- Location d'un local
- Electricité
- Salaire des ingénieurs et
- Salaire des designers
- Accessoires événement (band roll, cartes visite)

- b. Quels sont les coûts les plus importants pour notre entreprise ?

ما هي التكاليف الأكثر أهمية لشركتنا؟

- Coûts d'hébergement VPS
- Abonnement internet
- Salaire des ingénieurs et les designers
- Ordinateur

- c. Comment pouvons-nous réduire les coûts ou améliorer l'efficacité de nos opérations ?

كيف يمكننا خفض التكاليف أو تحسين كفاءة عملياتنا؟

- Nous avons déjà nos propres ordinateurs.
- Nous avons déjà les notions de bases dans le développement web.

9- Revenus (Revenue): مصادر الدخل:

- a. Quels produits ou services nos clients sont-ils prêts à payer ?

ما هي المنتجات أو الخدمات التي يكون عملاؤنا على استعداد لدفع ثمنها؟

La créativité, simplicité et efficacité de notre dossier patient numérique et l'organisation de notre plateforme rend notre service recherché et demandé, or les clients seront prêts à payer pour en bénéficier.

- b. Quels sont les différents moyens par lesquels nous pouvons générer des revenus ?

ما هي الطرق المختلفة التي يمكننا من خلالها تحقيق الدخل؟

- Contrat de travail
- Accès selon les fonctionnalités (chaqu'une son prix)
- Mises à jour

- c. Quel est notre modèle de tarification ?

ما هو نموذج التسعير لدينا؟

Ce n'est pas encore fixé



جامعة أبو بكر بلقايد
UNIVERSITY OF TLEMCEEN



Business Model Canevans : BMC

Partenaires clés Key Partnerships الشراكة الرئيسية

- Ingénieurs en informatique.
- Experts en marketing
- Experts en cyber Security

Activités clés Key Activities الأنشطة الرئيسية

- Développement web
- Renforcer la cyber Security
- Adopter un Design ergonomique
- Collaborer avec des consultants en marketing et marketing digital
- Collaborer avec ministère de santé

Ressources clés Key resources الموارد الرئيسية

- Médecins spécialistes en radiologie et en médecine nucléaire
- Hôpitaux publics et privés
- Cliniques
- Centre d'imagerie médicale

Proposition de valeur Value Proposition القيمة المقترحة

- Réduction des feuilles.
- Création des dossiers patients numériques
- Réduction du temps passé à la recherche des dossiers patients archivés
- Facilité d'accès aux antécédents du patient
- Archivage des images, rédaction et impression des comptes rendus dans une seule fenêtre.
- Accès au compte à tout moment via un ordinateur, tablet ou un smart phone

Relation clients Consumer Relationship علاقة مع العملاء

- De bouche à l'oreille
- Foires
- Publicités
- Online

Canaux de distribution Channels قنوات التوزيع

- Via téléphone
- Via email (donner l'accès à la plateforme)
- Paiement par baridimob (ou carte de crédit)
- Se déplacer à l'intéressé

Segment client Customer Segment أنواع العملاء

- Hopitaux
- CLCCs - Centres de Lutte Contre le Cancer
- Cliniques

Coûts Coste structure التكاليف

- Ordinateur (écran, unité, souris, clavier)
- Télévision, équipements de bureau(tables et chaises ...etc)
- Data show
- Coûts d'hébergement VPS, abonnement internet, location d'un local, et électricité
- Salaire des ingénieurs et les designers
- Accessoires événement (band roll, cartes visite)

Canaux de distribution Channels قنوات التوزيع

- Contrat de travail
- Accès selon les fonctionnalités (chaqu'une son prix)
- Mises à jour

