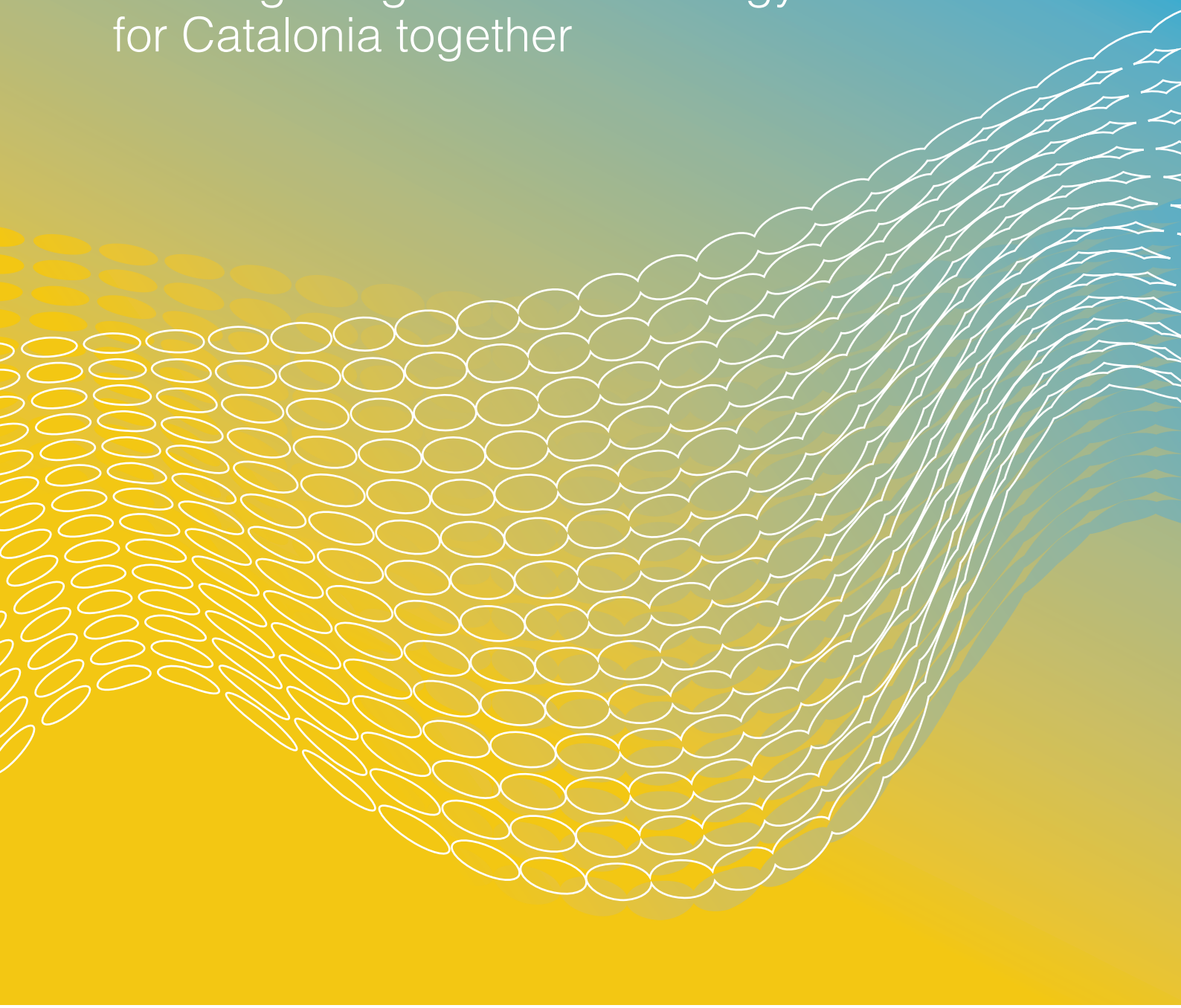
The Catalan Information Systems Master Plan

Building a digital health strategy for Catalonia together



Generalitat de Catalunya
Departament de Salut

Pla Director de
Sistemes d'Informació

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Building a digital health strategy for Catalonia together

"The purpose of looking at the future is to disturb the present"

Gaston Berger

Presentation

Thank you notes

The demographic, social, political, and economic challenges we face as a society in the twenty-first century are of great importance and have a high impact on healthcare systems throughout the world, and Catalonia is no exception. The 2016-2020 Healthcare Plan identifies the challenges for improving the healthcare system. We want to reduce social inequalities in health, deliver more coordinated and integrated social care and healthcare, ensure that benefits and services meet people's needs, base the system's actions on prevention, and facilitate professional leadership and a more active role by citizens through introducing greater transparency and making innovation the driving force behind transformation.

Our healthcare system is an international benchmark in the incorporation of new technologies in different fields, such as Catalonia's shared electronic health record, interoperability among healthcare centers, access to personal data through La Meva Salut [My Health], electronic prescriptions, and digital medical imaging, among others.

Catalonia's forward-looking 2016-2020 Healthcare Plan incorporates the Digital Health strategic line to provide service and support to the remainder of the Healthcare Plan's strategic lines. We need to organize ourselves better and offer a more agile and decentralized management model if we want to address the challenges ahead of us, take advantage of the capacity and potential of the *Sistema Sanitari Integral d'Utilització Pública de Catalunya* (SISCAT) [Integrated Public Healthcare System of Catalonia], and respect the independent management of healthcare centers.

The Catalan Information Systems Master Plan presented herein was designed to respond to the challenges we face together, placing all information users at the heart of its very design. We hope that this proposal serves to address all our common objectives and allows us to build a more just, effective, and sustainable healthcare system.

David Elvira

Director of the Catalan Health Service (CatSalut)
Ministry of Health of the Government of Catalonia

I am pleased to present the Catalan Information Systems Master Plan, which aims to guide the development of information systems and information and communication technologies in the coming years. The idea is to enhance and move the Catalan Healthcare System forward and help achieve the goals set by the 2016-2020 Healthcare Plan.

With a strategic, technical, and pragmatic vision, the Plan has focused on responding to the information needs of people and professionals working throughout the healthcare system and in collaboration with other areas, such as social services or education, that contribute to people's health and wellbeing.

Clinical, managerial, and planning decision-making is increasingly based on the value that the availability of accurate and quality information adds at the right time. This is the starting point for the reflection on current information systems and how these systems should evolve to get the best value out of the data collected systematically. Once these data have been properly processed and analyzed, they can be key in finding ways to improve people's health and the quality of healthcare delivery.

To respond to these information needs, the Plan proposes the development of the Electronic Health Record (EHR) and SISCAT's analytical repository, the improvement and renovation of clinical and healthcare work environments, as well as the digital transformation of healthcare delivery processes and models through the emerging technologies that are making our lives easier in numerous areas.

These proposals are the result of a joint effort with the sector through different participatory mechanisms for professionals in the health and technology areas, who know the reality of the healthcare system and are involved in its improvement. On behalf of the Strategic Committee of Chief Information Officers (CETIC), I would like to thank all participants for their significant contribution to the design of the technological solution that will allow us to achieve the objectives we established together as a system.

Pol Pérez Sust

General Coordinator of Information Systems
Ministry of Health of the Government of Catalonia

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Foreword

The patient's point of view

My name is Joana and I am 78 years old. I live alone on the third floor of a building that has no elevator. My two children live far away, but they come to see me often. I have suffered from many diseases for a long time: high blood sugar, high blood pressure, and more. Also, I've been having breathing problems for the last few years when I go out for a walk, and my doctors told me that I had a bad heart condition. I usually go to an outpatient care center once a month and take six pills a day. Despite all this, I'm able to lead a fairly independent life.

Last Thursday I fell down while walking to the market and passed out. A neighbor called emergency services. The ambulance showed up and I was taken to a hospital Emergency Room (ER). They called the emergency unit from the ambulance to inform them that I probably had a broken leg.

I came around as soon as we got to the ER. The emergency doctor said I had a broken leg. Then he looked up data on his computer about my diseases, the medication I was taking, and the tests that I had undergone. With this information he figured that I had probably fainted due to the betablocker I was taking. I was diagnosed with syncope, heart failure, and a fracture of the femoral head. He told me that the way to proceed in such a scenario was to have an operation within the next two days.

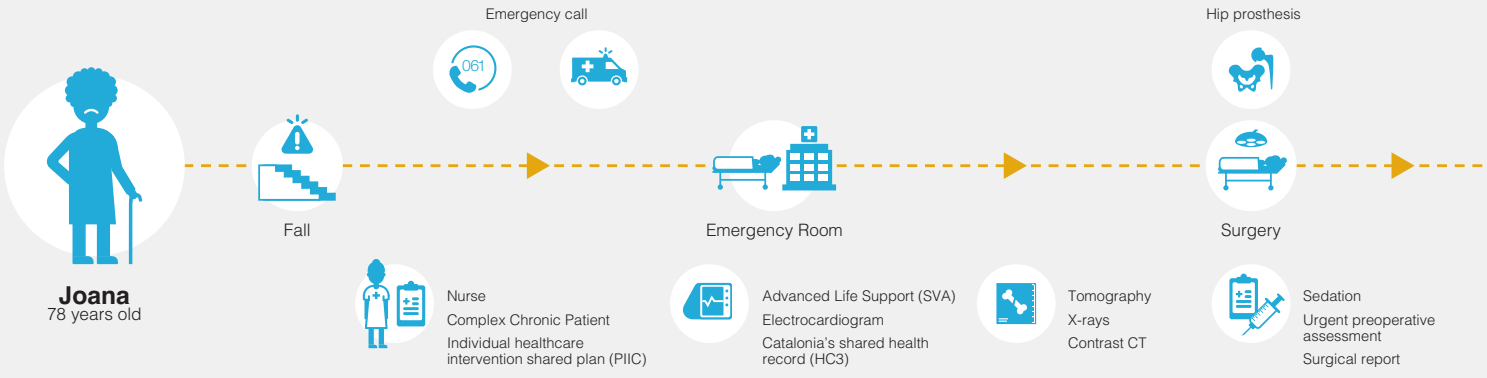
I was admitted to the hospital to have a hip replacement. I had lots of tests done on my head and heart and I was told that everything was normal. The operation went as planned and I was discharged from the hospital the following Monday morning. Before that, the hospital had notified my outpatient care center of my discharge and a nurse case manager did some pain and dependency tests on me. The social worker verified that I didn't have a home care service but that I did have a telecare service. They both worked out a comprehensive care plan, prescribed a home rehabilitation support service, and activated it for me right on the spot.

On Thursday afternoon the primary care nurse came to visit along with a social worker. They did a health screening on me and went over the drugs I was taking. The nurse told me that a physical therapist would be coming the next day to start home rehabilitation. She also showed me a system that would allow me to do telerehabilitation, access La Meva Salut [the citizen's personal health folder], and communicate with my children. And all of this together in one place: on my cell phone!

The physical therapist came on Friday and we started rehabilitation. Before he left, he showed me the exercises I had to do on my own to complement his rehabilitation sessions and programmed them on my cell phone app.

A few weeks later, the home care nurse told me that I had recovered quite well and scheduled an outpatient visit with my doctor. The doctor had learned of my incident through an alert he had received on his computer and had also sent me a message in case I needed anything. He asked me how I was feeling and I told him that I still had some discomfort. He scheduled additional rehabilitation sessions for me at the specialized center. When I told him that I had difficulty getting there, he activated a health transport service that would take me to the rehabilitation center every day and that the date and time for those sessions would be on my cell phone's agenda.

Today, after 30 days, I was able to go to the market by myself again.



The professionals' point of view

The Medical Emergency Service (SEM) operator took Joana's neighbor's phone call and put him through to the nurse. She noticed the PCC tag (complex chronic patient) on Joana's health record then she checked the PIIC (ndividual healthcare intervention shared plan). With this information, she decided that Joana required immediate attention and sent an Advance Life Support team to her.

A first overall assessment was done in the ambulance, together with an electrocardiography (ECG) that was checked against the one she already had on her health record. This information was entered on the mobile device. The report was sent to the emergency department along with the suspected fracture and likely problem. All this was transferred to the patient's health record.

The emergency department received notification of an arriving patient with a suspected fracture and prepared for the examination. The emergency doctor reviewed the patient's history and repeated the ECG. The results were different from those of the previous ECG. She had a right bundle branch block, but without an abnormal heart rhythm. Given the patient's loss of consciousness, the doctor also decided to do a head computed tomography (CT) scan to rule out a stroke, despite the fact that the neurological examination had been normal. The automatic contrast image showed slight changes with respect to the previous contrasts in the patient's record, so the neurologist had to assess the results. The radiographic examination confirmed a fracture to the femoral head and, as indicated by protocol, surgical intervention was scheduled for the next day. A request for an urgent preoperative assessment was automatically received by the anesthesia service.

In the operating room, the surgeon implanted a hip prosthesis and wrote up the surgical report that was immediately available in the health record.

Once Joana was transferred to the ward, she recovered well. The day after the operation, the workstation generated an alert for the social health worker and the nurse case manager to carry out an integral assessment of the patient's needs and her social and family support. Following this assessment, a comprehensive care plan was established. This plan identified that the patient had a telecare service activated and that, with a few hours of home care service (SAD) and rehabilitation, Joana was likely to be discharged early.

The primary care nurse, who had been monitoring the process since Joana's arrival at the emergency room, received a new PREALT (pre discharge) protocol activation alert.

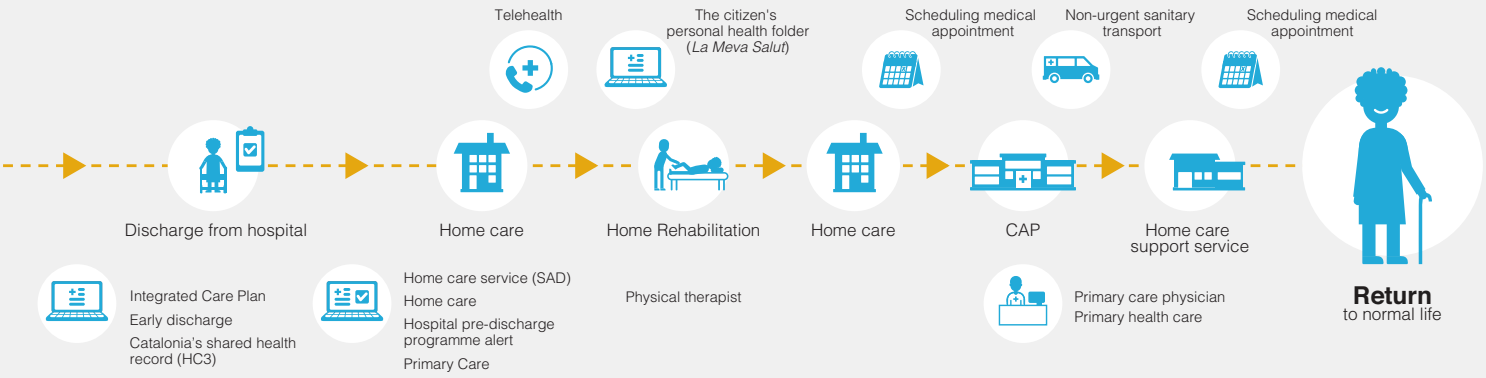
Joana left the hospital on Monday morning. In the afternoon, the primary care nurse went to see her and brought the social worker with her. She did the required follow-up care treatment, reviewed her medication, and informed her that a physical therapist would come the next day to begin the rehabilitation process. The nurse also installed the telehealth app on her cell phone and showed her the main features, including how to access La Meva Salut [the citizen's personal health folder], a system to communicate with her family, and telerehabilitation.

The next day, she did the first rehabilitation exercises under the guidance of her physical therapist, who also set up a telerehabilitation plan for her that was complementary to the home rehabilitation.

A few weeks later, the home care nurse assessed the case and discharged her from care. She also scheduled an appointment with her primary care doctor for her. Then she checked the follow-up of the case on the medical record and sent a message to her cell phone of the doctor's availability. As the patient had some discomfort, the doctor scheduled rehabilitation sessions in a specialized center. Through the SEM, the non-emergency transport company was automatically sent the corresponding scheduled ambulance trips. Joana had the agenda of rehabilitation sessions available on her cell phone.

Thanks to the technological platforms, all healthcare professionals who have been involved in Joana's process have had access to all the information that was being generated at all times, which supported their decision making with respect to healthcare solutions.

In a cross-cutting, integrated healthcare model for the provision of care services, it is essential that the professionals involved in healthcare delivery processes have top-quality, homogeneous, and timely information for decision making. Within a scenario of multiple care providers in all healthcare delivery processes, the central role of information systems can ensure coordination of all the professionals involved.



Executive summary

Like the healthcare systems of other advanced countries around the world, the *Sistema Sanitari Integral d'Utilització Pública de Catalunya* (SISCAT) [Integrated Public Healthcare System of Catalonia] is subject to stress, challenges, and opportunities that derive mainly from the aging of the population, the growing cost of the public healthcare system, the incorporation of new technologies and medical treatments, and a greater level of knowledge and demands from citizens.

In this scenario, a key issue is the transformative role of data management and information technologies for the empowerment of the patient, healthcare practices, health management, and resource allocation.

Healthcare has been identified as one of the sectors with the most potential for intelligent data use. In terms of operations, it allows clinicians to share patient health information throughout the care spectrum (primary care, hospitals, social healthcare, or home care delivery). In terms of management, it facilitates transparency and comparison to reduce the variability of care practices and increase the quality and safety of care delivery. In addition, it allows regulators, insurance companies, and customers to establish contracts and economic conditions. At the analytical level, it is an opportunity for research into new treatments, services, and products that fulfils the promise of personalized and predictive medicine. In all cases, patients are provided with access to their data and information as their relationship with professionals and the healthcare system carries on. Healthcare is a sector in which information and knowledge play a key role.

Here in Catalonia, the Healthcare Plan is the strategic, interdisciplinary, and collaborative framework that guides the actions of all SISCAT stakeholders to improve the quality of life and wellbeing of the population, ease access to and increase the performance of health services, and make the system more efficient and sustainable as a whole. One of the strategic lines of the Plan (number 10) is aimed at "digital health" or "eHealth." In addition to this specific objective, information systems should facilitate the improvement and transformation of the healthcare model and healthcare system in accordance with the purposes and strategies of the Healthcare Plan. Some of the core ideas of the Plan, such as integrated care delivery throughout the entire care process, accessibility and performance, drug policy, assessment and transparency, and regional integration, among others, explicitly request actions from information systems and technologies.

The Information Systems Master Plan has been designed to achieve these objectives. That is to say, it is not only or mainly a technological update, but a model for data management and an information systems architecture that corresponds to, and in some cases is ahead of, the changes that are taking place in the healthcare model in terms of citizens' relationships with the healthcare system, the work processes, and the relationships between the professionals themselves. It is for this reason that its approach is systemic in that it covers the exchange of data between different assistive devices and even with other areas (e.g. social services). Consequently, it affects some aspects of the tools used by healthcare service providers. For this reason, it also provides mechanisms to strengthen collaboration between the various stakeholders, to define semantic and technical standards, and to share and take advantage of technological innovation.

Information systems managers and technicians within the Ministry of Health and healthcare service providers have taken part in its design, as well as professionals and experts of healthcare delivery, health management, and health planning from a broad range of areas, while the Directorate of the *Servei Català de la Salut* [Catalan Health Service] has sponsored it. All in all, almost three hundred people have been involved in the project over a period of nine months and through different mechanisms.

Objectives and benefits of the Master Plan

From the point of view of the use of ICTs, the Catalan healthcare system successfully overcame what could be labeled the "first wave" of digitization. In the initial stage, information technologies were incorporated within the healthcare service providers themselves with the aim of supporting the work of professionals (as in the case of clinical workstations and, largely, nursing workstations, both in primary care and in hospitals), some departmental systems (imaging, radiology, and operating rooms), and in enterprise infrastructure systems (financial, personnel, procurement management, etc.).

Simultaneously, the Catalan healthcare system has been able to undertake initiatives from countries leading in the use of information and communication technologies for the benefit of citizens and professionals, such as the creation of the *Registre Central d'Usuaris* (RCA) [central user registry] and the personal health card, the *Estació Clínica d'Atenció Primària* (ECAP) [Clinical Workstation for Primary Care], the electronic prescription for pharmaceutical benefit services, or the health information and documentation exchange systems. Examples of these systems include the *Història Clínica Compartida a Catalunya* (HC3) [Catalonia's shared health record], the interoperability platform (IS3), the medical imaging digitization system (SIMDECAT), or La Meva Salut [the citizen's personal health folder].

Despite this, the use and effective adoption of these initiatives has not been universal, and the quality and timeliness of data required by patients and professionals is also unsatisfactory. A strength such as the diversity of solutions adapted to its environment (enabling innovation to emerge) has become a limitation for future progress, creating a myriad of systems that do not seem to interact – even those that are based on standard solutions from the same manufacturer – due to the particular customizations of each local implementation.

Finally, planners, insurers, and service users have evolved towards greater regional management in healthcare demand and greater information needs in the most diverse areas. This has resulted in a great deal of demands to adapt the systems used by healthcare service providers and created different pathways for recording and sending information that do not contribute to an improved provision of healthcare services.

It is therefore necessary and urgent for SISCAT to take a quantitative and qualitative leap in terms of its services and information technologies to build a data-based, patient-centered information system that provides an integrated vision of health and facilitates continued monitoring of the patient, regardless of the professional or care provider who treats them at any given time. This new model must provide professionals with common information of clinical significance, information that is relevant and quality and easy to record, access, and analyze when it comes in need. Data management and the proposed technological model must enable the extension of new care models, allow the automation of voluntary tasks, and improve ease of access to information by the patients and patient interaction with the system.

Key features of the new information systems model

The longitudinal *Historial Electrònic de Salut* (HES) [Electronic Health Record] is the key element of the Master Plan and consists of a functional and technical repository of all relevant information on citizens that needs to be recorded and shared throughout the healthcare system. It is a conceptual and technological evolution of the health and medical records currently stored in the systems of the various care providers, which are based on different approaches with few or no connections between them. A common health record solution must take into account and align process components (how events are made and recorded and the citizen's health journey through the healthcare system), data components (a shared structure and nomenclature), and a technological model (how data is recorded, stored, and transmitted).

The Master Plan and its integration methods will be built in coexistence with existing systems. Having a common record means having a process of accreditation and standardization with respect to data that are thought to be commonly shared, the service levels, and the technical mechanisms for updating the information in real or near real time. This repository will gradually replace the current systems, which are based on interoperability (HC3 and IS3) and the delivery of records through multiple pathways, and will allow different stakeholders to look up the data they need at any time.

Sharing more high-quality data will make it possible to query and analyze large amounts of information, as well as compare risk factors and different health practices and treatments, in order to send the results back to the patients, professionals, and healthcare managers and to improve decision making and move closer to achieving predictive and personalized medicine. The Plan establishes the construction of an advanced analytical repository for the processing of structured and unstructured data (text, image, information from sensors and electromedical devices, and info entered by the users themselves) in near real time – which is now called big data – to provide SISCAT with products and data services.

The Electronic Health Record (EHR) also aims to be part of a comprehensive information system that has different value services and that can be offered to health service provider entities that need or wish to evolve or transform their current systems. We refer here mainly, but not only, to work environments, that is, the tools that healthcare professionals use to record and sort their work, whether it is administrative work (e.g. income management systems, internal transfers to wards, and discharges) or the work done through healthcare, clinical, or nursing workstations (e.g. systems for managing requests and work orders and recording diagnoses and treatments).

Some of the existing systems, such as the primary care clinical workstation (ECAP), must be thoroughly updated technologically. This update is a good opportunity to create an integrated model of citizen data that jointly takes into account the patient's condition and health issues with the logic of acute episodes, regardless of where they occur. In this way, the ECAP database will be the core of the central data repository, with which it will be integrated naturally.

In some hospitals, workstations have recently been implemented and are already consolidated. They will only need to go through a short-term accreditation process that makes them compatible with the new eHealth

record and that is part of the accreditation system of the health entities and agencies contracted by Catalan Health Service.

In some other cases (whether they are acute care hospitals or socio-sanitary centers), change is deemed urgent and essential. As for the latter, the Master Plan must be an opportunity to rationalize the existing offer and offer healthcare providers who need it the opportunity to encourage migration to more robust and modern systems. In this respect, the model provides for the construction (or acquisition) of a new hospital management system that, like in the primary care system, is integrated natively within the EHR.

This model, which is "coordinated" technologically and "participatory" in its governance, is well-aligned with a healthcare model that needs to share information and that is integrating care services in Catalonia, while maintaining management autonomy in the design of its processes and organizational models. The new technological solutions on the market, which are more modular-based and decoupled and feature greater ease of integration, will facilitate these design options.

The implementation of the longitudinal EHR can be considered a "second wave" of digitization. The international healthcare systems we have analyzed have been addressing them over the last few years, both those that are vertically integrated (that is, where the regulator and planner are also the owners of the service provider agencies) and those where different types of care providers coexist. On many occasions, diversified systems facilitate greater adaptation to the working methods of each entity and encourage local innovation. The health sector – also SISCAT in Catalonia – has pioneered the creation and application of digital transformation technologies, particularly in the field of telemedicine. Despite this, a range of factors have hindered the extension and mainstreaming of many valuable projects.

The Information Systems Master Plan aims to address this situation and facilitate a cooperative environment and an assessment and deployment process. The main objective is to provide the critical mass and economic dimension that is necessary to allow growth and exploit innovation throughout SISCAT, especially in relation to the technologies that facilitate redesigning care delivery processes, the deployment of new care models, and the development of the new EHR. This is the case for Big Data initiatives, telehealth, and mobile health provisioning, the Internet of Things (connectivity of medical, industrial, or personal devices), and Artificial Intelligence.

Governance

To ensure the success of the Plan, SISCAT must have a model of governance for information systems that combines executive and regulatory leadership with involvement and advice from the service-providing entities, and communities of practice for the development of the model must also be fostered. We could say that such governance is participatory, with a body in place that represents the service-providing entities for the strategic monitoring of the Plan, technical advisory bodies for the adoption of standards, and the accreditation processes and light structures that facilitate collaboration and knowledge management of the community. Within this participatory model, leadership and involvement form caregivers in the design and implementation of the solutions will be key.

The governance model is boldly designed to put the Catalan healthcare system on a par with the most advanced organizations in data and technology management. These organizations recognize the strategic role that information systems play in supporting and transforming their work processes and rely on data to make decisions anywhere in the institutions, even more so when their users are highly qualified professionals. This recognition is typically associated with a corporate ICT governance, stable and recognized management bodies, a top-level managerial position of its managers, and an adequate allocation of economic, technical, and human resources.

For the Plan to be effective and credible, it is necessary to determine a specific financing framework that facilitates its implementation. The financing of investments in technology will have to be earmarked (with incentives that favor the renovation of technology and its alignment with the information model proposed) and sustained over time. In addition, sufficient funding will have to be maintained in order to achieve the objectives of the Plan. It will also be necessary to review the model of relations with the *Centre de Telecomunicacions i Tecnologies de la Informació* (CTTI) [center for telecommunications and information technologies] to adapt it to the specificities of the healthcare sector and to the fact that a significant part of the agents and subjects involved in the transformation process are not bodies pertaining to the Generalitat of Catalonia.

For the implementation of the Plan, an ambitious, yet flexible and realistic executive program has been established. This program aims to work on strategic projects that leverage change, make improvements on current projects and services to make them converge with the future model, and promptly carry out actions and make decisions, including the termination of services and workflows that do not add value. In the short term, construction and initial loading of the central data repository is expected to be done with the information that is currently available in the system and that comes from different sources (CMBD, HC3, RSA, etc.) with the aim of making it available for the community that makes up SISCAT.

1

Introduction

1. Introduction

The first chapter opens with the background and justification of the project as part of Catalonia's Healthcare Plan. It further describes the Plan's objectives and scope, as well as its organization and preparation method.

The Plan responds to the mandate of establishing a digital health strategy for Catalonia beyond aspects purely related to technology. For this reason, we have considered a work method that broadly includes the involvement of a wide range of professionals with different backgrounds (care workers, managers, and technologists), both from services linked to the Ministry of Health, the Catalan Healthcare Service, and other central bodies such as the entities providing health services in particular.

1.1. Background: Catalonia's Healthcare Plan

"We are committed to cross-cutting work, breaking down the barriers in the organizations to which we belong, and seeking dialogue, partnerships, and collaboration."

Presentation of Catalonia's Healthcare Plan 2016-2020.

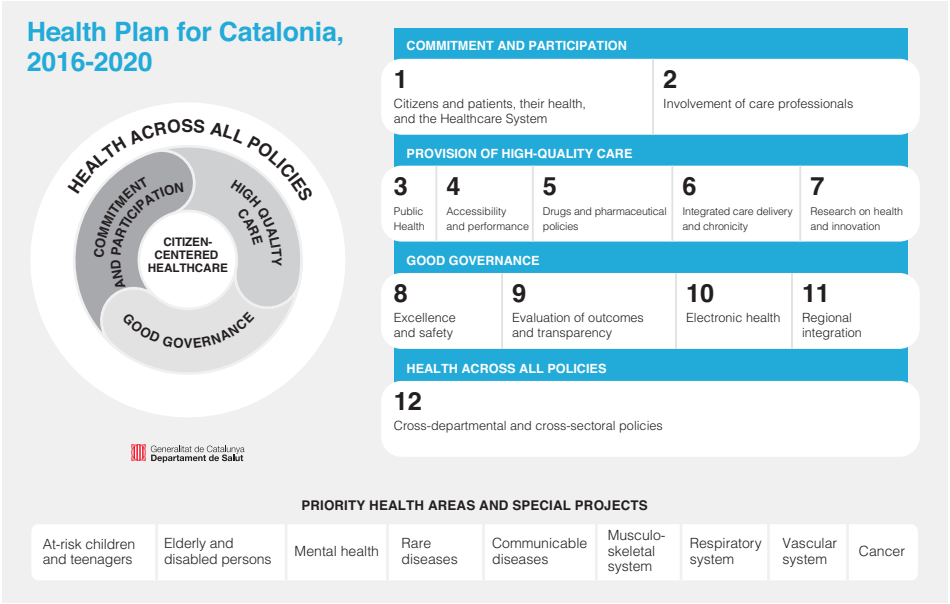
The *Llei d'Ordenació Sanitària de Catalunya* (LOSC) [law on the organization of healthcare in Catalonia] of 1992 establishes the **Healthcare Plan** as the "indicative tool and reference framework for all public health actions" (LOSC, art. 62). After seven editions, this planning format has established itself as a **cross-cutting, interdisciplinary, and interdepartmental** work tool to address increasingly demanding and complex health goals and problems.

The Healthcare Plan sets out twenty-eight health goals which are tackled in a structured way through an array of priority areas, areas of transformation, strategic lines, and projects. One of the strategic lines (number 10) focuses on "**digital health**."

In addition to this specific objective, information systems must also facilitate the **improvement and transformation of the healthcare model** and the healthcare system in line with the purposes and strategies of the Healthcare Plan. Some of the core ideas of the Plan, such as integrated care provision throughout the care continuum, accessibility and performance, drug policy, assessment and transparency, or regional integration, among others, explicitly call for actions from information systems and technologies (ICTs).

In this respect, and by Resolution of the General Secretariat of the Ministry of Health on November 20, 2016, the ***Comitè Estratègic de Responsables de les Tecnologies de la Informació i les Comunicacions*** (CETIC) [Strategic Committee of Chief Information Officers] in the healthcare environment was established. This board was commissioned to "lead the development of the new Information Systems Plan for the Catalan healthcare system, aligned with the Healthcare Plan." The board consists of managers from the field of information systems of different care providers that are part of the integrated public healthcare system of Catalonia (SISCAT). It is chaired by the General Coordinator of ICT in healthcare, which forms part of the General Secretariat of the Healthcare Department.

Healthcare Plan for Catalonia, 2016-2020



The actions proposed by the 2016-2020 Healthcare Plan for Catalonia are structured across four areas:

- **Commitment** and **involvement** of both citizens and care professionals to empower them and improve health and the healthcare system.
- **Healthcare delivery** with services that are accessible, integrated, and effective.
- **Good governance** to enhance assessment and transparency, ensure safety, carry out research on health-related issues, and adapt to regional needs.
- **Health across all policies** to strengthen cross-sectoral and cross-departmental work and ensure **equity** in health.

The Healthcare Plan sets out 28 healthcare objectives, within 9 priority areas, 4 areas of transformation, and 12 strategic lines, with a total of 58 projects. For the 2016-2020 period, the Healthcare Plan also establishes 10 priority healthcare areas that were singled out because they are the causes of mortality, morbidity, disability, drug dependence, and suffering and pain in general.

"I think it is very appropriate to align the Healthcare Plan as a strategic reference for the sector with the Information Systems Master Plan, which represents the strategy for ICTs."

Physician at the Participatory Event, July 12, 2017.

1.2. Objectives and scope of the Master Plan

"To generate a unified network of information systems, useful for the organization of the system itself, care practice, decision making, assessment, and accountability. To develop new models of citizen interaction with the healthcare system, remote healthcare delivery, organizational changes, and the role of professionals."

Founding principles of Catalonia's Healthcare Plan 2016-2020.

In accordance with previous proposals, a **Preliminary project** was carried out during the months of February and March 2017 to clarify and define the objectives and scope of the Master Plan. To carry out this project, in addition to studying the Healthcare Plan, the work sessions with the project, and an initial analysis of comparable international initiatives, in-depth interviews were conducted with professionals, experts, and managers from different areas of healthcare, management, and information systems.

The main objectives are to:

1. Consolidate a **model** of citizen-centered **information systems** that facilitates care and management decisions throughout the care spectrum.

2. Define a model for **governance** of SISCAT's information systems which has strong support from the community and guarantees its continuity.

3. Establish a **financing framework** that allows the implementation of the Plan and the adequacy and sustainability of the information systems model over time.

4. Create spaces and opportunities to design and implement **innovative**, citizen-centered, and ICT-based **healthcare delivery services**.

5. Establish an ambitious but realistic **roadmap** that allows the implementation of the new model in a safe, successful, and lasting way.

Regarding the scope of the Master Plan, it should be kept in mind that the Catalan healthcare model establishes a health system (SISCAT) which is structured around **planning** and **regulatory** processes run by the Ministry of Health, **insurance**, **resource allocation**, and **programming** processes are run by Catalan Health Service, and **service provision** processes are run by different care providers in the fields of primary and specialized care, mental health, and social care delivery services.

The Integrated Public Healthcare System of Catalonia (SISCAT)

The **Integrated Public Healthcare System of Catalonia (SISCAT)**, which integrates all healthcare networks into a single system, was created in 2000. SISCAT makes it possible to define a stable framework of healthcare service providers and draw upon a wide range of healthcare resources of different characteristics and ownership deployed in Catalonia.

This deployment and the collaboration model between different healthcare service provider entities have enabled Catalonia to offer one of the most far-reaching national healthcare systems with the greatest accessibility and performance in Europe.

Currently, SISCAT is made up of:

- 71 hospitals,
- 369 primary care delivery teams,
- 96 inpatient intermediate care facilities,
- 41 inpatient mental healthcare facilities,
- 422 medical transportation and other health delivery services (rehabilitation, oxygen therapy, etc.).

The Ministry of Health of the Government of Catalonia or the Catalan Health Service holds an interest in the following entities:

- 15 public companies:
  - 8 public law entities subject to the private legal system
  - 7 commercial companies
- 16 consortia
- 1 foundation

The SISCAT information systems must provide support to all these processes and information for decision making to the different stakeholders in the value chain and to their professionals and managers.

Therefore, the project does not consider the management infrastructure and support processes carried out by centers with full autonomy and departmental information systems.

"The project is key if we want to have an integrated vision of the patient within Catalonia, promote communication and establish care processes beyond each center, and provide transparency and facilitate assessment."

Hospital manager.

Integrated Public Healthcare System of Catalonia (SISCAT) value chain

The time scope of the Plan covers the period of **2018-2022**. The fact that the information systems master Plans fall between two strategic plans (or healthcare plans, in this case) is customary in all economic sectors to ensure the continuity and persistence of these policies.

What is an information system?

Information systems are popularly linked to "new technologies" (computers, communications networks, data processing centers, or computer programs). In reality, this is only a partial and incomplete view. Information systems deal with how real people use data and technology in real organizations and in a real context.

We could say that information systems are like a double-sided coin:

- One side constitutes **data**, **processes**, **and work relationships** that are typical of the activity, which are encoded and sorted so that they make sense and can be worked on. For example, a medical consultation requires identification of the patient, access and interpretation of their medical record, registration of a series of actions, diagnoses and procedures, and a series of work orders (tests, referrals, applications for admission, etc.).
- The other side constitutes technological support through a set of **devices**, **software**, and **technical infrastructure**: databases, management applications which reflect the logic of work processes, other exchange and communication applications, and a presentation layer with which we interact as users, among other increasingly sophisticated tools.

To the extent possible, the Master Plan tries to answer questions and propose solutions to the problems and needs related to the use and adoption of technology by all SISCAT professionals. It also aims to improve the effectiveness of planning and management to benefit individuals and the healthcare system.

1.3. Method and work process

"Involvement and care leadership in the design and implementation of information systems in the healthcare sector are key to their adoption and effective use."

Primary care physician.

Preparation for the Master Plan was carried out between February and November 2017 and was structured in a Preliminary stage and four stages:

1. In the **first stage**, a comprehensive analysis of the initial situation was made. It aimed to show and document the need for the project through a survey of the technical and economic situation of current information systems and from the point of view of the needs as perceived by the different SISCAT stakeholders.

   Also, the most recent international experiences in strategic planning of information systems in the healthcare sector were reviewed.

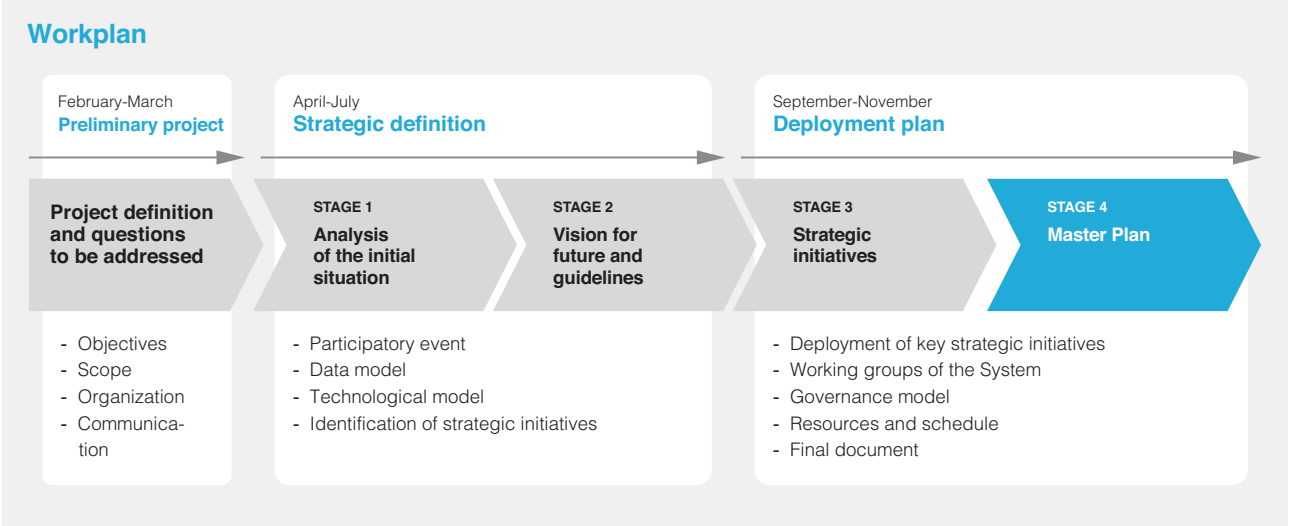
2. The **second stage** was aimed at establishing the vision for the future of information systems, that is, the specific features that SISCAT's new information and data management model should have in order to achieve the objectives laid down in the Healthcare Plan. At this stage, the collective aspirations of the healthcare community were compiled through a series of interviews and a participatory event, which was held on July 12, 2017 and was attended by SISCAT professionals from several different backgrounds.

   The analysis of the gap existing between the desirable situation and the current situation gave rise to a first definition of the strategic initiatives which will be the roadmap with which the vision will be realized.

3. In the **third stage**, these initiatives are deployed through specific working groups consisting of personnel with technical and functional backgrounds within the system itself which are coordinated by a project office. The outcomes are the characterization of the initiatives with different levels of depth based on their critical nature and a specific action plan for each one. A wide array of professionals recommended by the Project Management team or invited by the associations representing the different entities in the healthcare sector have participated in this stage.

4. In the **fourth stage**, the results obtained by the working groups are integrated, the deployment plan is prepared, and the roadmap and critical factors are identified to ensure successful execution.

Workplan



1.4. Project organization

Since its inception, the Master Plan has been conceived as an internal exercise within the Catalan healthcare system, yet keeping an eye on the experiences of the international environment. The process has combined the leadership of the Ministry of Health, Catalan Health Service, and different provider entities with various mechanisms of structured participation: almost 70 interviews, a participatory event with more than 140 attendees, and the division into working groups of over 150 professionals over two months for the deployment of strategic initiatives.

The main project management bodies were:

- **The Plan Management Body**. In accordance with the Resolution of the General Secretariat, the General coordinator of ICT in healthcare and the Strategic Committee of Chief Information Officers (CETIC) are responsible for leading the Plan. It is made up of five information systems managers from service-providing entities. They are responsible for the key deliverables.

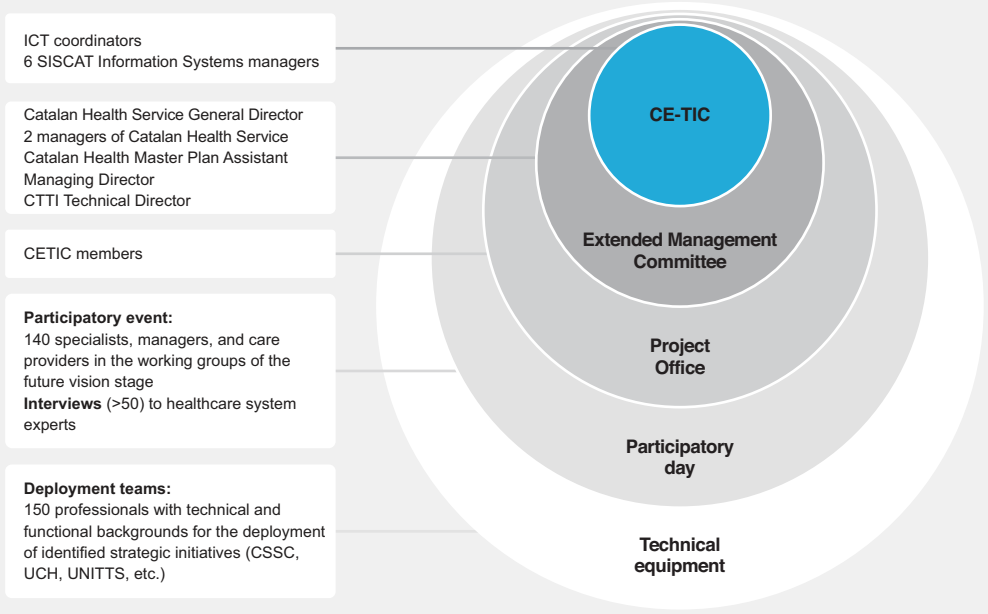
- **The Management Board**. Given the characteristics of the project and its strategic nature, the involvement of managers from the Ministry of Health and Catalan Health Service was considered imperative. Given his role as the key political driving force behind the project, the executive director of the Catalan Health Service chairs the board.

- **The Project's Office**. This office has been responsible for the day-to-day management of the project and the preparation of the main resulting documents. The General coordinator of ICT in healthcare, some of the members of the CETIC, and a support team have all been part of this office, under the supervision of a SISCAT project manager.

"A process of these characteristics and complexity is the result of a delicate combination of top-down management and bottom-up participation of the different stakeholders in the system. It simply cannot be a technology project for technologists."

A manager in the Catalan Health Service.

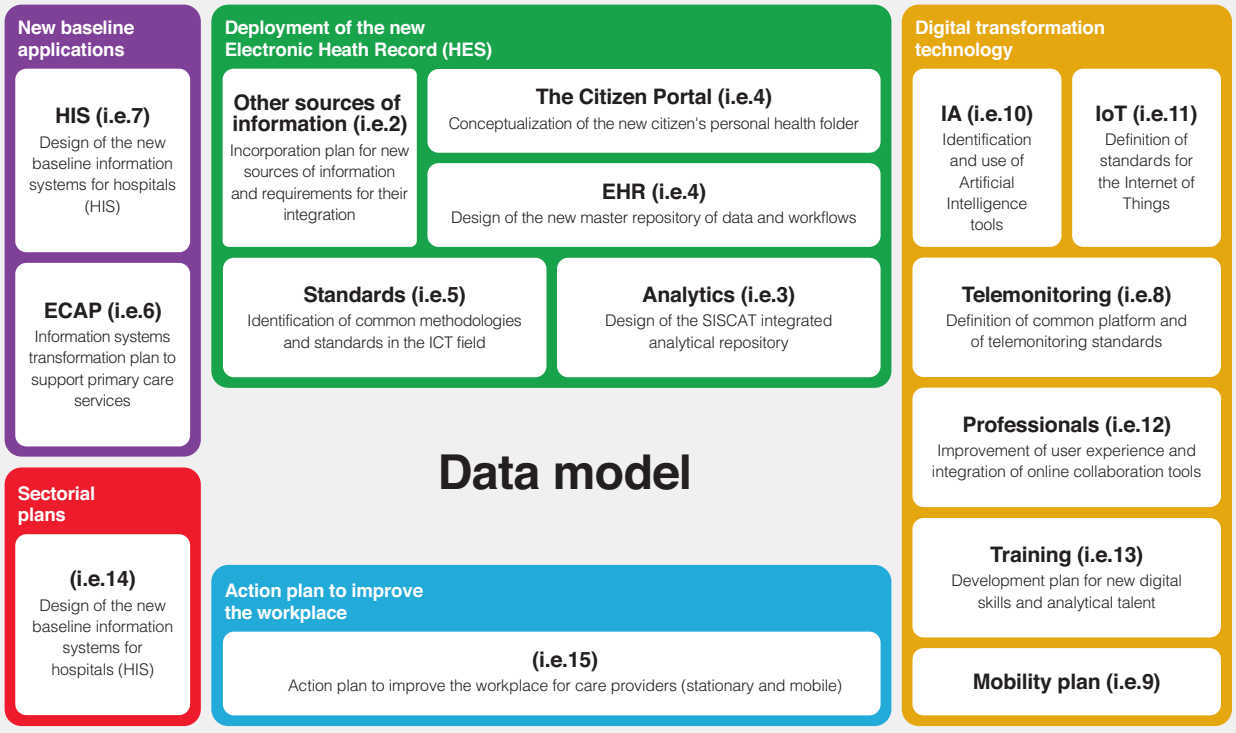
Project organization



- **The deployment working groups.** As a result of the strategy definition phase (stage 2), five lines of work were defined, deployed in fifteen strategic initiatives to work on the key features of the defined future vision. Professionals from the service-providing entities were invited to join in and the care provider associations (the *Consorci Sanitari i Social de Catalunya* and the *Unió d'Hospitals de Catalunya* [the health and social consortium of Catalonia and the union of hospitals of Catalonia]) were asked to partake. In addition, the association that brings together the information systems managers of SISCAT (UNITTS) were asked to invite their members to join the initiatives. The response from all of them was overwhelming.

The following graph shows how these groups were organized. The product resulting from the work of these groups is published separately from this document.

Organization of working groups in the deployment stage



1.5. Product structure

The main outcomes of the Master Plan are laid out in this document, which is structured into the following parts:

0. An **executive summary** of the most important ideas of the Plan.

1. An **introduction**, in which the background, objectives, and organization of the project are presented.

2. **Benefits and justification of the Plan.** In this part, the main challenges of healthcare systems throughout the world and for SISCAT are presented, as well as the benefits that the transformation of the information systems model for assistance, planning, and management of services are expected to bring.

3. **Key features of the new information systems model.** In this part, the key concepts of the new model are summarized, in particular the creation of the longitudinal Electronic Health Record (EHR), the planned actions on the legacy system and workstations, the incorporation of a new range of technological innovations within SISCAT, and the governance and financing model that must accompany these initiatives.

4. The **Electronic Health Record**, with a high-level description of the data model and the different elements of its technological architecture, as well as its use, operation, and evolution, including the development of an advanced analytical environment and a new personal health space for citizens.

5. **Healthcare workstations.** This part focuses on the actions undertaken in care work environments, both in primary care and specialized care.

6. **Digital transformation technologies.** In this part, both the priorities and process of incorporating technological innovations into SISCAT are established, especially those that complete the defined information systems model: Big Data, Telesalut [telehealth] and Mobilitat [mobility], the Internet of Things, and Artificial Intelligence.

7. **Governance of ICTs within SISCAT.** In this part, the critical success factors of the Plan are defined, particularly the creation of a managerial role with a stable structure, a model of participatory governance, and a specific financing framework.

8. The **Transformation Plan.** This part deals with the implementation approach, which is structured around the construction of the new EHR and its data repository through progressive approaches.

9. **Next steps.** This part includes a series of actions to be implemented during the Plan's first year of implementation following its approval.

Document structure

"A strategic information systems plan has to provide a vision for the future and establish a roadmap to achieve it; it must propose a technological architecture and a model of governance and financing."

Working group.

The Ministry of Health has launched a webpage (http://pdsis.blog.gencat.cat) where additional outcomes of the work that has been carried out and other related documents can be looked up. It includes, among others, outcomes of the participatory event, an analysis of international trends for the reform of health-related information systems, the core document of both the data model and the technological model, and, especially, the outcomes obtained by the fifteen working groups that have carried out the deployment plans from the spectrum of strategic initiatives that make up the Master Plan.

It can be concluded that the Plan has been created as an indication for the development of the **Digital Health** strategy of the Health Plan, but it soon became evident that the implications of the Plan for information systems went much further.

Thus, the objectives of the project were expanded, as were the governing bodies and the work method so as to voice the concerns of the health community as a whole and facilitate their active participation throughout the design process.

2

Benefits and justification for the Plan

2. Benefits and justification for the Plan

In this chapter we examine the **challenges** health systems are facing worldwide and their implications for information systems and technologies. Next, we explicitly identify the **benefits of the Plan** to improve the quality of care delivery, facilitate the work of professionals, and improve the efficiency and equity of the healthcare system. We also introduce some references on the **current situation** that allow us to visualize other opportunities for improvement.

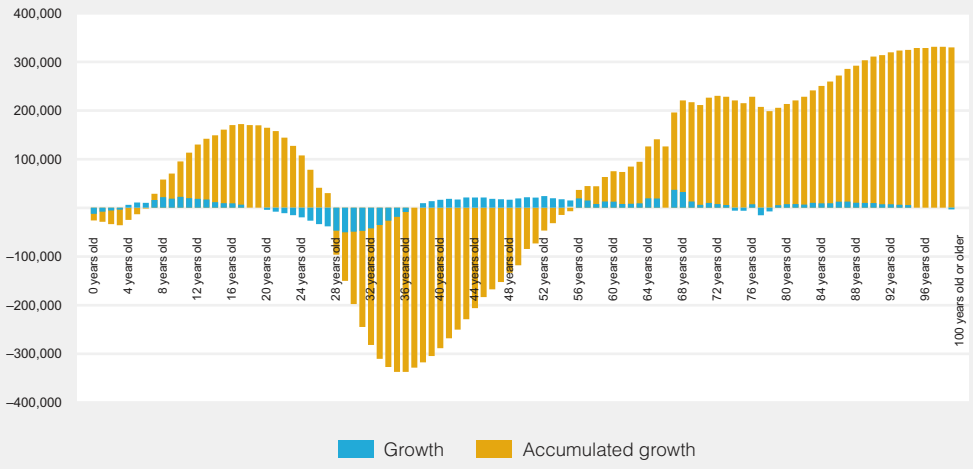
2.1. Common challenges of healthcare systems

"The challenges facing healthcare in Catalonia are common to all other healthcare systems worldwide."

Working team.

The global challenges facing Catalan healthcare are common to other healthcare systems around the world. Medical advances and the emergence of technology in medicine and healthcare practices are changing the healthcare delivery paradigm as we have known it to present. **Demographic changes**, increases in life expectancy of the population, aging, and the resulting increase in chronic diseases are surely the biggest challenges facing modern societies from all perspectives, but with a very significant weight in the provision of health and social services.

Population increase (January 1, 2007 - 2017)



Source: Institut d'Estadística de Catalunya (https://www.idescat.cat/pub/?id=ep&n=9123&t=201701)

The aging of the population is also the main cause of the steady **increase in costs** for healthcare systems, but there are others such as advances in nearly every branch of medical treatments, health technologies, and pharmacology.

To simultaneously maintain the quality and sustainability of healthcare systems (particularly those with universal coverage), **better integrated and collaborative care** is required between different systems and professionals inside and outside the health

system itself. Prevention, community care, and the development of new care models (other than onsite care delivery at the doctor's office or hospitalization) are becoming increasingly important.

Digitalization is leading to the **democratization of access to information** and the change in the role of patients, who want to be actively involved in the process of healthcare delivery. In parallel, the technology market is making different applications and devices available for citizens to control and measure health, and which range from mobile applications to various types of biometric sensors.

Technology is also increasingly present in the field of health institutions, where the separation between medical technologies and information and communication technologies is becoming blurred. Phenomena such as hyperconnectivity, social networks, collaborative online work, the Internet of Things, the cloud, Artificial Intelligence and robotics, and genomics can jointly result in a revolution in epidemiology and public health, the planning and management of healthcare systems, and the practice of health professions.

Among all these transformations, the most disruptive ones are perhaps **analytical intelligence** and Big Data, which encompass the capacity for registration, storage, retrieval, and exploitation of huge amounts of health-related data in any type of format (numerical, text, image, and so on). Highly sophisticated analyses – and even predictive ones – can be made by means of this capacity, and provide added value to the stakeholders of the healthcare system. In this way, it is possible to anticipate risk conditions, provide more effective and personalized evidence-based care, reduce the variability of care practices, and allocate resources that are costly and scarce more accurately.

Challenges for healthcare systems

- Demographic, social, and health changes: chronicity
- Increasing costs and stresses on the sustainability of the universal healthcare system
- New care and integrated care models within and beyond the healthcare system
- Patient autonomy and empowerment
- Digitization: intensive use of data and ICTs
- Purchase of services based on outcomes and evidence
- Predictive and personalized medicine

2.2. Implications for information systems

In this context, what should the information systems of the future be like? What goals will they have to achieve? And what benefits should they bring to the sick and their families, to health professionals, to care and non-care managers, and to health planners?

With the analysis performed, which includes a review of international initiatives and trends, the **mission of information systems is identified** in the field of health and healthcare, which must be put at the service of the actions established in the Health Plan for all the actions of the healthcare system:

"To provide people, professionals, and all stakeholders of the healthcare system with information and knowledge to improve the health, quality, and wellbeing of people, as well as the equity and efficiency of the system."

The current evolution of information and ICT management and the accumulated functional and technological knowledge in the Catalan healthcare system, based on local initiatives of different service-providing entities and other general entities in Catalonia, allow us to aspire to a higher

"The information we already have is like a buried treasure chest. We have to dig up the chest and discover what's inside."

Hospital practitioner.

"The new information system should allow sharing data and working cooperatively, incorporating more visions beyond the strictly health related, and establishing a different relationship with the patient, one which is more proactive, preventive, and focused. In fact, it should be a more personalized, proportional, and human relationship even though it may seem the opposite."

Physician and manager of an entity providing integrated care services.

state of development with the following **characteristic features**:

- The information system must be **citizen and patient centered**, regardless of the professional or care provider who can process them at any given time. This model should provide an integrated vision of the patient's health and wellbeing, of their interactions with the healthcare system, and other aspects that affect their health throughout their life.

- The information system must provide technological support for **care delivery** and **integrated and continuous monitoring** of the patient. It should also help to establish contacts within the system and encourage collaboration between different professionals and healthcare teams.

- The new model must provide professionals with **shared information of clinical significance** that is relevant, timely (whenever it is required by the user), high quality, and easy to record, access, and analyze.

- The system must incorporate functionalities that allow for **the query and analysis of large amounts of information**, as well as comparing risk conditions and different practices and treatments to help decision making and research.

- The information system must include advanced functionalities that facilitate addressing more widespread and complex health problems (such as those derived from chronicity and multiple pathologies) and the **development of new care delivery models** that can replace onsite care delivery.

- New technologies must allow **automation of tasks that do not add any value** and an increase in quality time dedicated to patient care.

- The new technologies must facilitate patient access to their data, increase their level of information and knowledge, and allow **interaction** and active **involvement** with their health.

- The use and massive analysis of more data from more sources should gradually facilitate the discovery of patterns and feedback to patients, professionals, and managers to improve decision making and advance towards **predictive and personalized medicine**.

Throughout its recent history, the Catalan healthcare system has been able to carry out **leading initiatives** in the use of information and communication technologies for the benefit of citizens and professionals, such as the creation of the *Registre Central d'Usuaris* (RCA) [central registry of users] and the personal health card, the *Estació Clínica d'Atenció Primària* (ECAP) [Clinical Workstation for Primary Care], the monumental implementation of advanced hospital management systems in all hospitals in Catalonia, electronic prescriptions (ePrescribing) for pharmaceutical benefits, and systems for exchanging information and health documentation. Some examples of these systems include the *Història Clínica Compartida a Catalunya* (HC3) [Catalonia's shared health record], the interoperability platform (IS3), the digitization of medical imaging (SIMDECAT), and the citizen's personal health folder (La Meva Salut).

From the point of view of ICT use, the Catalan healthcare system successfully overcame what could be considered the "first wave" of digitalization. This initial phase consisted of **incorporating information technologies within the service providers themselves** in order to support the work of professionals (clinical workstations and, largely, nursing care workstations both in primary care units and hospitals), some departmental systems (image, radiology, or operating rooms), and company infrastructure systems (management of finances, personnel, purchases, and so on).

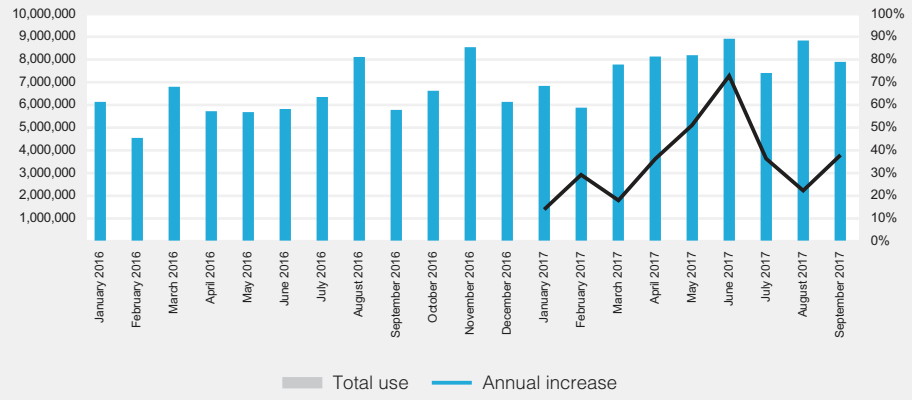
The Catalan healthcare system has also been able to incorporate innovation through local initiatives (in the fields of telemedicine and mobile devices). These initiatives have been deserving of trust and dissemination within the European Union and have allowed the growth of an interesting local industry.

SISCAT's interoperability systems (I)

The shared health record in Catalonia (HC3), the interoperability platform (IS3), the citizen's personal health folder (La Meva Salut), and the eConsulta [eConsultation] are the most widespread mechanisms used for the exchange of information and documentation within the system.

HC3 consists of a document viewer in PDF format. As of today, 80% of all care providers can access and feed information into this document. It includes more than 213 million laboratory, emergency, radiology, and ultrasound reports, among others. More recently, structured data from certain diagnostic tests have also been incorporated. The level of updating and use is variable, but in recent years there has been a significant increase in the amount of information and it being accessed for consultation.

HC3 usage



IS3 is a service that allows health service providers to handle a wide range of interactions and work requests between different care levels, such as referrals, telemedicine, and alert notifications.

It currently includes the most common or basic processes, which have generated almost two million requests over the last year among 85% of SISCAT care providers.

SISCAT Entities	Alt Pirineu i Aran	Barcelona	Camp de Tarragona	Catalunya Central	Girona	Lleida	Terres de l'Ebre	Overall Total
Connected								
Hospital care	14.29%	6.72%	1.37%	8.54%	7.45%	4.00%	2.38%	6.35%
Primary care	75.00%	86.30%	54.79%	84.15%	74.47%	94.00%	85.71%	81.61%
Total Connected	**82.29%**	**93.02%**	**56.16%**	**92.68%**	**81.91%**	**98.00%**	**88.10%**	**87.96%**
Associated								
Hospital care	0.00%	1.28%	4.11%	0.00%	3.19%	0.00%	0.00%	1.45%
Primary care	0.00%	4.13%	8.22%	0.00%	5.32%	0.00%	0.00%	3.57%
Total Acceding	**0.00%**	**5.43%**	**12.33%**	**0.00%**	**8.51%**	**0.00%**	**0.00%**	**5.08%**
Not connected								
Hospital care	3.75%	1.03%	2.74%	0.00%	1.06%	2.00%	7.14%	1.59%
Primary care	7.14%	0.52%	28.77%	7.32%	8.51%	0.00%	4.76%	5.42%
Total Not connected	**10.71%**	**1.55%**	**31.51%**	**7.32%**	**9.57%**	**2.00%**	**11.90%**	**7.01%**

"HC3 provides information, but not in a structured way to contrast it with other information and for decision making. For example, from a diagnosis, alerts should be generated and modified in relation to other patient information. In the event of a referral, the diagnosis, agreed tests, and relevant information should be included. The system should guide these requirements or offer process alternatives."

Primary care practitioner.

"The information system must be oriented to the decision making of all the stakeholders involved: doctors, nurses, managers, and the patients themselves. Therefore, we must unify data, processes, and nomenclature. All the information that anyone needs should be automatically fed into the system without having to look for it."

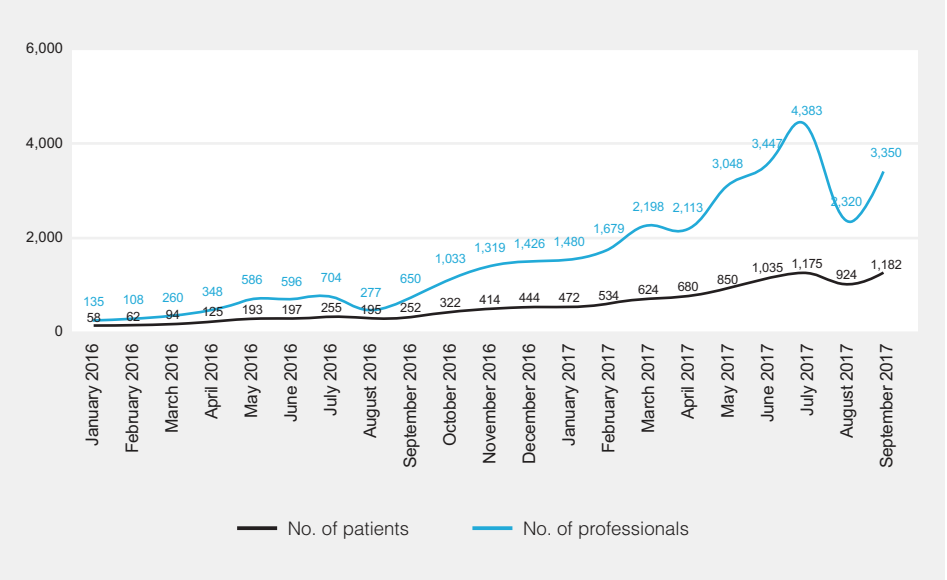
Conclusion of one of the working groups at the participatory event, July 12, 2017.

SISCAT's interoperability systems (II)

Within each care provider or integrated group of care providers, information sharing is much more advanced both in terms of access to the patient's administrative and medical information and the referral and monitoring of workflows. This is the case, for example, of different integrated health consortia throughout Catalonia or the *Institut Català de la Salut* (ICS) [Catalan Institute of Health].

La Meva Salut [the citizen's personal health folder] allows patients access to part of the content of the HC3 and the IS3 and, in some cases, the realization of procedures, such as scheduling visits for primary care and international vaccinations with the ICS, conducting online consultation with GPs, or requesting a doctor's note from a specialist.

eConsultation allows patients to communicate with healthcare professionals from remote locations, which makes it possible to speed up the healthcare delivery process.



2.3. Opportunities to improve the current systems

Despite this, the use and effective adoption of these initiatives is not yet widespread, nor can the quality and timeliness of data demanded by patients and professionals be regarded as satisfactory. Throughout the preparation of this Plan, and especially after the participatory event, working group sessions, and interviews carried out with different types of stakeholders in the system, it can be affirmed that the information systems currently in place are still far from achieving the objectives set out in the previous section.

Level of satisfaction of professionals in relation to information systems

Question	Average score
Current information systems allow clinicians to easily have timely, quality information with a sufficient level of detail for patient care.	3.46
Current information systems allow clinical managers to easily have timely, quality, and detailed information for decision making relative to clinical management.	3.16
Current information systems allow patients to easily move through different levels of care and outside the boundaries of primary and hospital care providers.	2.38
Current information systems have met professional expectations to facilitate the availability of information and the patient's journey through the system through interoperability (HC, IS3, LMS).	2.90
Current information systems are prepared to respond to new needs and care delivery models.	2.42
The current information systems are prepared to respond to the new demands that patients and professionals have developed with the internet connected devices they use in their everyday life.	2.34

Source: Participatory event, July 12, 2017. 1: highly unsatisfactory; 6: highly satisfactory. Participants: 137.

The diversity of local solutions adapted to their environment, which can pave the way for innovation to flourish and is therefore considered a strength, has become a potential limitation for future progress and created a large **disparity of systems** (up to 29, according to our analysis) that do not interact with each other (not even those based on standard solutions from the same manufacturer as they have been customized for particular local implementations). At the same time, the dynamics of the healthcare delivery model and organizational development has given rise to valuable **territorial integration initiatives based on new models of shared care delivery**, which are very hard to implement from the point of view of technological support due to the lack of standardization of information systems between system providers.

Finally, and with respect to managerial approaches, the planner, insurer, and "purchaser" of services has gradually shifted their attention to the specific demands for care in each local area and to the need for greater amounts on information in the most diverse fields. This has resulted in a large amount of demands for **adaptation of the systems in the centers providing care services** (which in some years, according to our analysis, can spend between 35% and 70% of the computing budget of the centers). It has also generated different workflows for **recording, reporting, and sending information** between the service-providing entities, Catalan Health Service, and the Ministry of Health (more than 50, according to our calculations), which do not add value to the delivery of care services.

This situation is unsustainable for the health system as a whole and for many service centers individually, especially the smaller ones, which, as a general rule, cannot afford technological renovation.

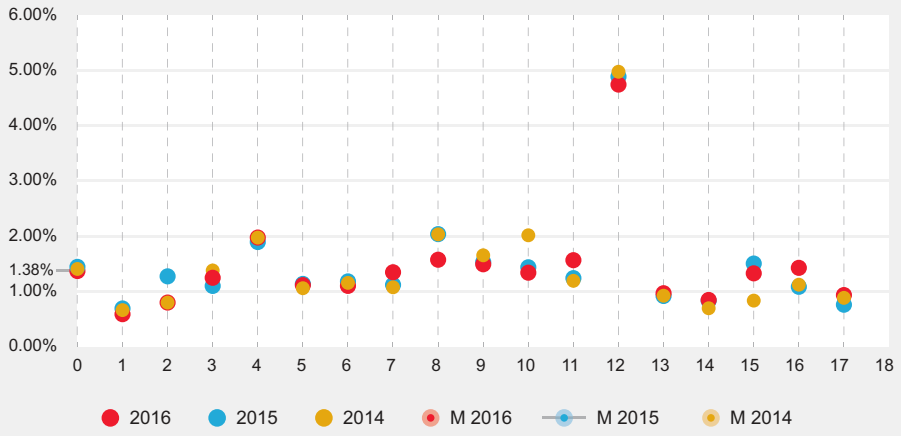
"We can discuss whether we spend a lot or a little, but the distribution is uneven and inefficient."

Hospital IT manager.

Current situation of the SISCAT information systems (I)

The overall budget with respect to health expenditure (2%) is above the national average (1.38%), but far from the world average of 4.5%.

Overall ICT budget with respect to overall health budget in %

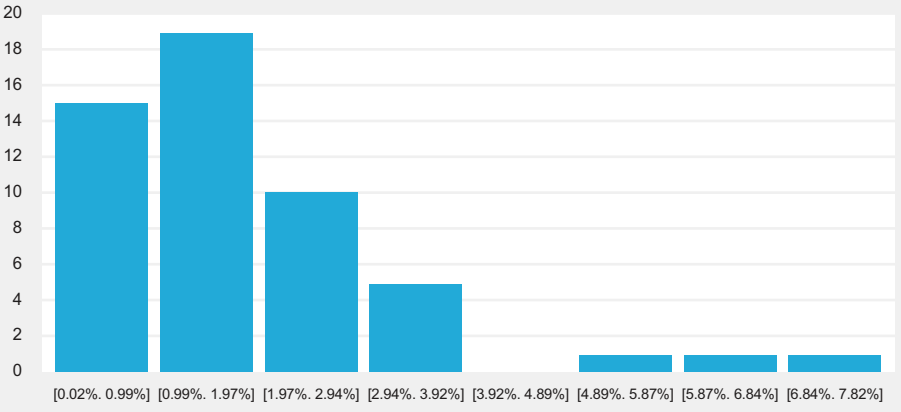


Source: Índice SEIS (2016).

But expenditure has a **highly uneven** distribution throughout Catalonia. For example, 15 centers have an expenditure of less than 1%, and 8 centers, which are generally the bigger ones, are above 3%.

Overall expenditure with respect to overall health expenditure in %

(52 valid answers)



Source: TicSalut. Mapa de tendències [Map of trends] (2016).

Current situation of the SISCAT information systems (II)

The legacy systems are relatively outdated and far from being appropriately renovated or beginning an update cycle that responds to current and future needs.

Average age of the SISCAT service-providing applications

		Application						
Family	**Product**	**CW**	**NCW**	**B**	**DP**	**AM**	**PA**	**CDD**
Transactional (HIS)*	SAP	6	5	7	8	8	3	12
	SAVAC	9	8	10	7	10		10
	HCIS	2	8		1	6		
	DESNV PROPI	15	19	20	10	26		6
	TESIS	11	11	5				
Departmental	Gespath						6	
	PATWIN						12	
	SILICON				6			
	GACELA		6					
	NOVOPATH						5	
Analytics	MINERVA ANALISI							3
	Business Objects							7
	QLIKVIEW							4
	OFIMATIC							10
	Global	9	8	12	8	11	10	6

CW	Clinical Workstation	**PA**	Pathological Anatomy	**CDD**	Care Delivery Dashboard
NCW	Nursing Care Workstation	**DP**	Dispensation in Pharmacies		
AM	Administrative Management	**B**	Billing		

Source: UNITSS survey (2017)

Note: The Hospital Information Systems (HIS) include various integrated ancillary systems, whereas in other cases the departmental systems interoperate with the central HIS.

Highly uneven situation among SISCAT hospitals.

It must be kept in mind that the different installations of the SAP system are mutually incompatible as they will depend on the type of implementation in place.

The information systems of the service-providing entities with a transactional SAP product are not compatible with each other (Argos ICS, Hospital Clínic, Hospital de Salut PAU, CSI, Hospital de Mollet, Hospital de Sant Joan de Déu de Martorell).

Our analysis also highlights the high number of data processing centers with **insufficient relative maintenance** or the lack of **disaster recovery centers**, especially in smaller centers.

It could be said that a legacy system that is as large and scattered and managed with the same amount of resources as in other regional communities is necessarily more unequal and less flexible and globally scalable, except in the case of some larger and better equipped health service providers.

On a national scale, in vertically integrated health systems (in which the regulator and planner is also the owner of the service-providing centers) it is easier to establish unified information systems strategies, although sometimes this is only possible by being connected with a single care provider, which is undesirable, or by limiting the potential for progress and innovation of local initiatives.

Despite this, the analysis of international trends shows that in systems where local management autonomy with multiple care providers is valued and enhanced, there is also a tendency **to**

"Every time we must develop a new functionality, change a version, or respond to a request from Catalan Health Service, we all have to do the same on our end. Are the things we do so different?"

Hospital IT manager.

"The paradigm shift that the most advanced countries and regions have already made is to move from the medical record (Electronic Medical Records or EMR) to the common longitudinal health record (Electronic Health Record or EHR) for the entire healthcare system."

Information systems manager of an entity providing services for SISCAT.

incorporate general governance, reduce the number of technological solutions, and, above all, **use standards** that make citizen information available to everyone in a single longitudinal health record for the entire service provision chain.

This design option is not the short-term replacement of the operational systems that care providers use, but rather the deployment of rationalization and harmonization strategies based on practical improvements of existing solutions.

The creation of a single electronic health record in New Zealand

"International experience also demonstrates significant benefits of a single electronic health record, both in terms of productivity and quality. There is a general trend towards a single purchaser or using a small number of advanced health systems, whether private or public."

"The health systems that have achieved the most important advances have evolved from strategies based on non-integrated systems (best of breed) or "virtual" electronic health records to the single eHealth record strategies (...) through rationalization and harmonization of current systems."

Source: Deloitte (2015). Independent review of New Zealand's Electronic Health Records Strategy.

It can be concluded that the improvement and transformation of the SISCAT information systems is necessary and urgent to face the challenges of quality and sustainability in healthcare, support new healthcare models, and reap the benefits and harness the potential of today's available technologies.

The new information systems must be person-centered and make the information and knowledge held by SISCAT available to all stakeholders (patients, citizens, professionals, managers, planners, and researchers), considering that current information systems only allow for limited sharing.

To obtain these benefits, standardization and harmonization strategies of different scopes are required, which are in line with those being carried out by countries with organizational and care models similar to those of Catalonia.

3

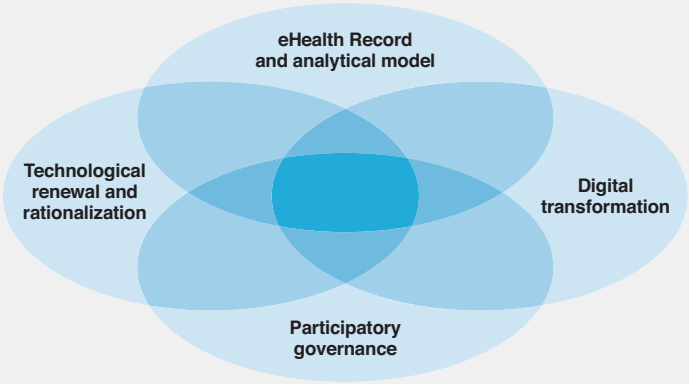
Key features of the new information systems model

3. Key features of the new information systems model

To bring into effect the benefits we presented in the previous chapter we must make a **quantitative and qualitative** leap with respect to the information systems we have today. This leap should allow sharing and exploiting the information and making it available to the community, supporting the needs for rationalization and renovation of the existing technological on offer, and capturing the potential of digital transformations that citizens and professionals already benefit from in other areas of their everyday life.

Meeting these challenges will not be possible without a governance model for SISCAT information systems that includes regulatory changes in the accreditation and contracting model and a financing framework that facilitates the adoption of technology. The model must also incorporate decision-making mechanisms that combine normative leadership and standardization with the involvement and commitment of the service-providing entities.

Main areas of the Information Systems Master Plan



3.1. Electronic Health Record and analytical model

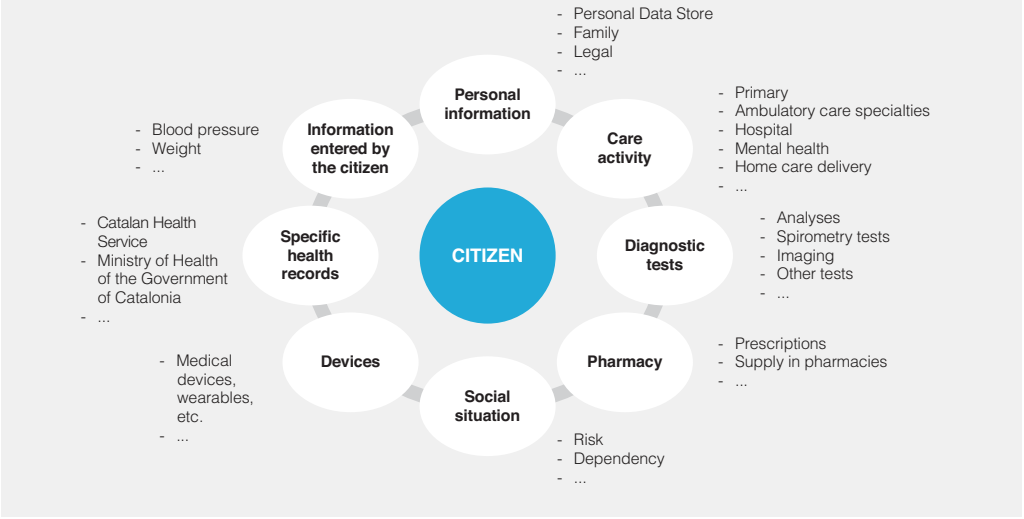
The mission of the new information systems model is to provide information and knowledge to all stakeholders in the health system (citizens, professionals, managers and planners, and regulators). The proposed model will allow sharing a language (a conceptual and semantic **data model**) and using technological tools (the longitudinal **electronic health record**) which are available to all in a safe and controlled way, with the necessary data to make decisions for the benefit of the health and wellbeing of citizens and the effectiveness and equity of the public system.

The **Electronic Health Record (EHR)**, the basic element of the Plan, is the functional and technical repository of all relevant information concerning a citizen that needs to be recorded and shared throughout the healthcare system. It is a conceptual and technological evolution of the medical records that are currently stored in the systems of the different health service providers, based on different approaches with no connection between them. A common health record solution must take into account and align **process** components (how the events and the citizen's journey through the healthcare system

are made and recorded), **data** components (a shared structure and nomenclature), and a **technological model** (how data is recorded, stored, and transmitted).

The Plan establishes the construction of the EHR and the methods for integrating the record into current legacy systems, within a more global technological architecture, which is made available to SISCAT. This repository will progressively replace the current systems, which are based on interoperability and transfer of records across multiple pathways.

Conceptual representation of the common data model



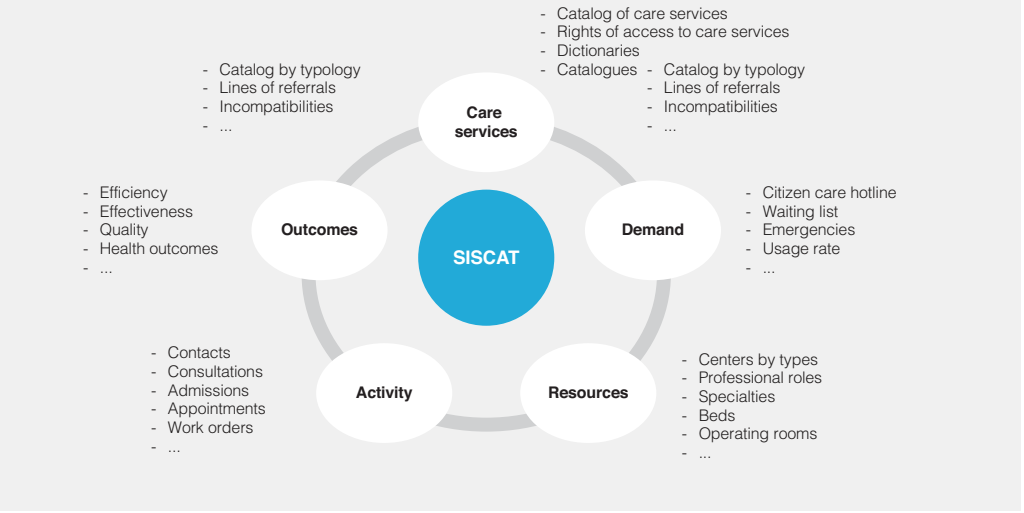
The Master Plan is a tool to promote the use and **massive analysis of data** with the aim of increasing the intelligence and knowledge of the healthcare community, identifying risk factors that help in prevention and prediction, comparing practices and outcomes from different professionals and care providers, and sharing such information to facilitate ongoing improvement. The Plan establishes the construction of a repository of aggregated data, indicators, and analysis tools which are available throughout SISCAT. This **advanced analytical repository** will include not only structured data, but also handwritten text recognition, images, information from sensors and electromedical devices, and information entered by the users themselves.

A data model with these features allows users to create reports, dashboards, and perform advanced searches and queries. It also allows them to perform from quite simple analysis to rather sophisticated multidimensional analysis on a large amount of data (known as **Big Data**).

"All centers must share highly-detailed data in a single repository that is accessible to all the stakeholders involved, with an adequate system of permissions: information coming from social care services, mental health, pharmacy, home care, microbiology, inspections, community care, clinical outcome, chronicity, nursing homes, security, etc. (...) We must unify processes and nomenclature."

Conclusion by one of the working groups at the participatory event, July 12, 2017.

Example of an analytical visualization



Having a common record involves a process of **accreditation and standardization** with regards to data that are considered to be commonly shared, service levels, and technical update mechanisms.

The new technological model will allow professionals and providers to access standardized and homogeneous **value-added services** throughout the sector so that benchmarking exercises can be performed.

3.2. Technological renovation and rationalization

"Information systems have been designed for management and billing, but not for clinical decision making."

Conclusions heard at the participatory event, July 2, 2017.

We refer here mainly, but not only, to **work environments**, that is, the tools that health professionals use to record and sort their work, whether it is administrative in nature (income management systems, internal transfers, and discharges) or done through care, clinical, or nursing workstations (systems for the management of requests and work orders and registration of diagnoses and treatments).

Some of the existing systems, such as the **Clinical Workstation for Primary Care** (ECAP), are in great need of a thorough technological update. The workstations of some **hospitals** have recently been implemented and are already consolidated. They will only need to go through a short-term accreditation process that makes them compatible with the new EHR. In other cases (acute care hospitals and intermediate care centers), change is urgent and essential.

The process mentioned above is an opportunity to rationalize the existing offer, propose a smaller number of reference solutions, and offer healthcare service providers in need the chance to migrate to more robust and modern systems.

The **technological architecture** of the model aims to give an effective and efficient

response to these different needs and facilitate its progressive implementation. The model provides for a **common core** consisting of the data repository and its basic services, a set of layers or services that facilitate exchange between different information systems, and a process of **approval** or **accreditation** of management applications.

Within this process, the design and construction (or acquisition) of **new transactional services** (general or ancillary applications) are envisaged. These services will be offered to the centers that need to make a partial or complete migration of their systems, either now or in the future. These services can be easily integrated with the care provider's own systems through standardized application interfaces, technically called Application Programming Interfaces (APIs). This services platform aims to be common to the entire chain of care services within an area in order to facilitate its progressive deployment, although it may be modular and decoupled.

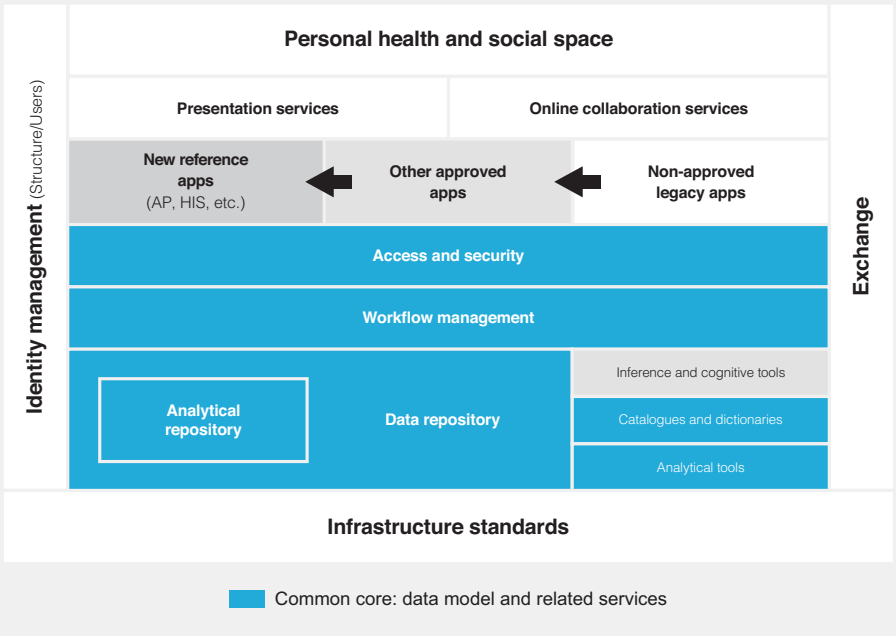
The proposed model (technologically "coordinated" and "participatory" in its governance) is well **aligned with a health model** that must share information and is integrating care services in Catalonia while maintaining management autonomy in the design of its processes and organizational model. The new technological architectures present on the market, which are more modular and more easily integrable, will facilitate these design options.

"The different cultures and ways of going about doing things are reflected in each ERP of each service-providing entity, as well as a great deal of knowledge of healthcare professionals, technology departments, and care providers. We have to preserve and take advantage of this knowledge."

Member of the deployment stage working group.

The technological model (I)

The technological model



The technological model (II)

The technological model can be represented as a set of layers or components, which are progressively displayed:

- The **common core** is made up of the data repository and the workflow manager. It also includes a set of related services: dictionaries and help with the registration and decision making of professionals, tools and repositories for information analysis, access protection and data management, and technical exchange standards. The standardized data of the systems of different care providers or other sources are integrated in real time or near real time into the common core repository.
- **Progressive deployment** services, which allow integration with the care provider's systems. Examples include a common, presentation-like browsing layer, or online collaboration and communication services.
- **Technical services**, such as those that allow integration of external applications or exchange with other systems (town halls, Education or Justice departments, etc.), an identity management service that ensures a unique identification of all users when accessing any application, multichannel and multidevice access, etc.
- Layer of **support for work processes** (applications) in different care areas (primary, specialized, social care, healthcare, mental health, etc.) and specific departmental systems, which will be subject to a process of approval or accreditation. Different systems will coexist in time, including a new reference platform with a natural integration in its core (that is, without data exchange between different platforms).
- The upper layer is the new **personal health and social space**, which supports multichannel access through a single contact point with the various services of the different service-providing centers, and where citizens can access their information and other services, interact with professionals, and carry out procedures.

3.3. Digital transformation technologies

"The goal of innovation cannot be to 'improvise inventions,' but to improve the health, healthcare, and work of the professionals themselves in the most universal and equitable way possible. The clinical effectiveness, level of patient and professional satisfaction, economic outcomes, and sustainability and extension of innovation must be evaluated."

Conclusion by one of the deployment stage working groups, December 2017.

Like in other economic sectors, information technologies in healthcare have traditionally been considered tools to support operations and work processes. Over the last few years, extreme connectivity, extension, and reduction of costs in processing capacity, data storage, and the development of certain specific technologies have been radically changing the ways to work and the relationships of organizations with their customers and users, suppliers, and partners. These factors are even contributing to the increase, modification, or creation of new products and services based on information. This process of intensive use of information and ICTs to thoroughly transform industrial organizations or sectors is called **digital transformation**.

Digital transformation technologies

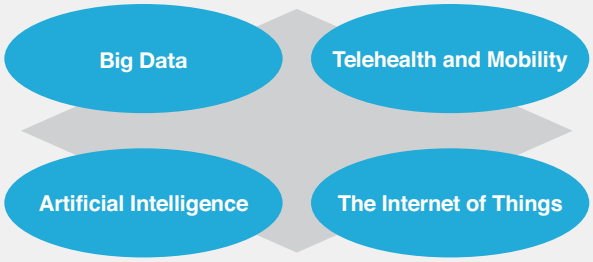
- Social networks and instant messaging.
- Mobile devices with capabilities akin to those of a computer.
- Processing and mass data analysis (Big Data).
- Increase in computing capacity and cloud-based services.
- The provision of connectivity for all types of devices and tools using sensors (the Internet of Things).
- The development of machines with learning and problem-solving capabilities (Artificial Intelligence and robotics).

The health sector has pioneered the development and application of these types of technologies. SISCAT has also been a pioneer with these innovations, particularly in the area traditionally called **telemedicine**: it has promoted projects via local initiatives of service-providing entities and privately-funded or EU-funded network initiatives and fostered collaboration with universities, local industries and public agencies such as the *Fundació TICSalut Social* [a health and social foundation devoted to innovation in ICT] or the *Agència de Qualitat i Avaluació Sanitàries de Catalunya* (AQuAS) [Agency for Health Quality and Assessment of Catalonia].

Despite this, a range of factors have hindered the extension and generalization of many valuable projects: the lack of a systemic vision in the design of some initiatives, the contractual and financing models, the lack of global governance, and, last but not least, significant budget shortfalls over the last few years.

The Information Systems Master Plan aims to address this situation and facilitate an environment of cooperation and a process of evaluation and deployment. The main goal is to provide the critical mass and economic dimension that is necessary to allow growth and exploitation of innovation throughout SISCAT. In preparation for the Plan, working groups made up of technologists and health professionals were created to try to establish a roadmap and guidelines in some key areas.

Areas targeted for digital transformation in the Catalan Information Systems Master Plan



Big Data

The analytical repository is related to the Electronic Health Record (EHR). It is only through this repository that the possibility of getting the amount and degree of detail of data necessary to perform sufficiently complex analyses can be obtained. The repository of structured data from healthcare will be enriched with **structured and unstructured information** from different sources and in various formats, such as social networks, public health records, or biometric sensors. The processing of this information will return to the Electronic Health Record (EHR) through different services and data products as tools to help decision making.

These new needs in terms of data volume, transmission speed, and variety require new types of hardware and software tools and ways in which to provide technical infrastructure services. The Plan proposes a technological architecture (called Data Lake) that allows working directly on the database repository (i.e. the transactional repository), adding semi-structured or unstructured information in multiple formats, and creating conventional Data Warehouses as well as different structures and analyses (not relational or not only relational).

In addition to computing power and the variety of analysis, such a model adapts much better to the characteristics of the healthcare sector and is more effective in removing the information silos often produced by conventional Data Marts.

"The family of Analytical Intelligence and Big Data solutions is the main investment destination in information systems in the healthcare sector."

Analysis of international trends.

Analytical repository use: examples

- Real-time dashboards, available to Catalan Health Service and to the service-providing entities.
- Comparison of different protocols for performing diagnostic tests and treatments.
- Comparison of relative efficiency in the provision of services of equal complexity.
- Identification of risk factors associated with certain pathologies.
- Text mining in emergency discharge or hospitalization reports for different uses.
- Programming of emergency services and capacity managment before outbreaks of certain diseases.
- Improvement of clinical and pharmacological guidelines based on a greater number of facts collected locally.
- Analysis of compliance with medication guidelines, presence at appointments or health checks, and similar.
- Prediction of health resources use for different levels of complexity according to health condition, social factors, lifestyle habits, etc.
- Improvement of the financing and billing model, including care modalities performed remotely and other conditions.

Telehealth and Mobility

"We need domestic collaboration tools, but which are both integrated with our work tools and are safe. We must also work on the incorporation of workstations to tablets and mobile devices."

Participant at the participatory event, July 12, 2017.

Patient care is evolving from the current model based mainly on in-person care delivery to a preventive model that is focused on continued care. Citizens and healthcare professionals alike will demand **more flexible care** practices through all kinds of mobile healthcare delivery services (informational, interactive, conversational, and transactional services) just as they already do in all other areas of their everyday life.

The development of telehealth – based on **new remote healthcare delivery models** – and mobility tools become key elements in the adaptation of care to the needs of the population, technology use (actively present in other areas), and system sustainability.

Telehealth areas

- **Telehealth**: remote health and social care delivery.
- **Telemonitoring**: remote control and monitoring of a patient's health.
- **Telecare**: remote care delivery service for immediate help to people who are at risk, have mobility problems, or do not have a caregiver.
- **mHealth**: provision of care delivery services via mobile technology (apps, etc.).
- **iHealth**: personalized, individual, and intelligent health.
- **Health 2.0**: health-related use of social networks (expert patients, communities of patients, and caregivers).

To facilitate its extension, governance processes that facilitate **evaluation and generalization** are required, as well as modifications in **service contracting** systems that involve monetary compensation and do not penalize these innovations.

Artificial Intelligence

Artificial Intelligence (AI) mainly takes advantage of the data possessed in the unified Electronic Health Record and feeds them back. It also builds **new products and services based on information**, such as AI-powered speech recognition or text analysis, diagnostic support, proposal or recommendation for treatments, response to consultations through natural language, pattern recognition and behavioral predictions, or control automation and resource planning.

According to the conclusions of the working group in this field, which include experience and literature, the use of AI in SISCAT is **complementary and not a substitute** for the work done by health professionals with the aim to increase the value, quality, and safety of healthcare practices.

Instances of Artificial Intelligence use in SISCAT

- Greater knowledge about the health of individuals and the population in general.
- Improvement of public healthcare systems.
- Improvement of the quality of clinical information and its processing.
- Care provision and decision-making support for doctors and nurses.
- Predictability of healthcare demand.
- Citizen empowerment.

"Public health is part of the healthcare system and, as such, it must use healthcare information and share tools to deal with other information, such as environmental and nutritional, to get a complete vision of what can determine an individual's health and the use that this individual makes of health and social services. It is also one of the areas with the greatest potential for predictive models."

A manager in Public Health.

The Internet of Things

The Internet of Things (IOT) refers to a very generic phenomenon of **connection** through the Internet or other networks (usually wireless) **of all kinds of objects** of everyday life or professional environments and health institutions. Examples include personal identification devices, medical devices in healthcare or home environments, personal sensor devices (called wearables), or any type of object with an identification and a sensor. The relationship between the Internet of Things and Telehealth and Mobility services is evident.

Like the examples mentioned above, healthcare is one of the sectors with the **greatest potential** for this type of technology that modifies the working methods and relationships between professionals, the sick, the machines, or any object in numerous ways. These connections produce data that can be stored and exploited within repositories in health centers and, eventually, in the common Electronic Health Record.

"Telemedicine has pioneered the use of the Internet of Things. Now we have to go a step forward."

Hospital practitioner.

Instances of Internet of Things use in SISCAT

- Monitoring and optimization of facilities, equipment, and workflows.
- Smart home environments that facilitate remote monitoring of patients.
- Environmental indicators for prevention and response in cases of risk or emergency.

In this transformation process, in addition to the evaluation and generalization criteria that are common to other innovations, there are special challenges of relevance, integrity, reliability, and **security of data** and the connections themselves in order to avoid fraudulent uses and ensure the protection of people.

3.4. Information systems governance

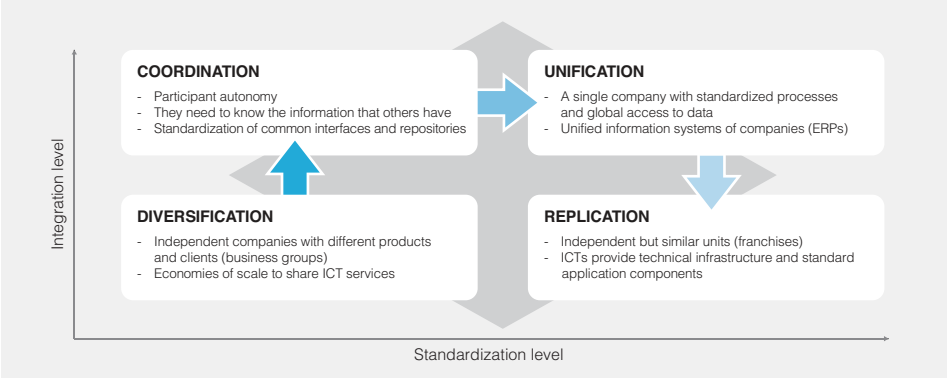
"Governance is the fundamental aspect for the credibility and execution of the Plan. Without governance it will only consist of good intentions. Governance must be consistent with the Catalan healthcare model and must count on and have the support of the service-providing entities."

Manager of a SISCAT service-providing entity.

For the above transformations to be effective, and based on the experiences we have examined and the consensus we have observed in the community, the Plan must have sufficient organizational and human resources and be sustained over time. It must also have stable, structural governance that is suitably adapted to the idiosyncrasy of the Catalan healthcare model, one which is based on leadership and participation.

If the Catalan healthcare model is a **coordinated model** that needs the sharing of information between its stakeholders and is moving gradually towards a greater integration of care service provision at the regional level, it is necessary to establish a model of information systems that is aligned with these objectives. Therefore, it is essential to overcome systems diversification first, then build and manage a single data model (through the longitudinal Electronic Record) and gradually incorporate transactional services (new work environments) that are more common and integrated, as already occurs mostly in primary care.

Integration and standardization levels (I)



Integration and standardization levels (II)

The proposed model has evolved from a **diversified** model (different data models and systems) to a **coordinated** model (data sharing). In some cases, and due to a shared interest of care providers and regulators, whether at the regional level or at the level of the entire Integrated Public Healthcare System of Catalonia (SISCAT), it can evolve towards more intense forms of sharing or a **unification** of some or all of its computer services, as already occurs in primary care.

The **governance of the information systems proposed for SISCAT** is based on the principles and values that the different stakeholders of the system share in terms of information systems and technologies regardless of local technological solutions. Governance also includes the management of common projects and services, a stable and finalist financing framework, and mechanisms for the involvement of service-providing entities in decision making.

To make this possible, a regulatory effort is required to share catalogues and dictionaries on resources, care provisions, workflows, and outcomes with clinical significance. This effort is part of the **accreditation system** of healthcare entities. There is also a need for the simplification of the current contractual systems that bind care providers and service buyers together, which are generally designed with the administration and with billing in mind rather than the care practice itself.

The governance model is ambitiously designed to put the Catalan healthcare system at the level of the most advanced organizations in data and technology management. These organizations recognize the **strategic role of information systems** in supporting and transforming their work processes and rely on data to make decisions at any point in the institutions, even more so when it comes to highly qualified professionals. Normally, this recognition is associated with a corporate ICT governance, a top-level managerial position of its managers, and an adequate provision of technical and human resources.

Information systems corporate governance areas

- Asset portfolio management and ICT investments.
- Organization and distribution of decision rights.
- Standardization and data management.
- Management of common IT services.

At the same time, the proposed model must be careful with the nature of the assigned tasks and the conditions set by the context:

1. Its first and foremost role is the management of the **transformation plan** itself, that is, the execution of the Plan, the design of its architecture, and the main strategic initiatives in the form of projects.

2. As a result of the Plan, **new products** and sophisticated **services** will be made available to the sector, usually in the form of applications, which will have to be implemented, maintained, and evolved through a structure specific to the competition for specialized care providers and the relationship with the *Centre de Telecomunicacions i Tecnologies de la Informació de la Generalitat* (CTTI) [center for telecommunications and information technology of the Catalan government].

3. Within the framework of projects and in the provision of services, the proposed model will have to **manage** quite varied and complex **demand**, set priorities,

"It is striking that, according to the annual report of the Spanish Society of Health Informatics, Catalonia is the only autonomous community in Spain where there is no information systems managerial role at the managerial level."

Working group.

involve stakeholders, and ensure high levels of service and satisfaction between customers and end users.

4. A relevant part of the model's role will not be the delivery and maintenance of its own projects and services, but the coordination of services that it won't manage directly. In these cases, it will be up to corporate governance to establish **processes of standardization** (of the data) and approval (of the solutions).

5. If the core of the Master Plan lies in the use, analysis, and **management of data**, a professional and specific governance of this area is necessary, as is a huge training program and a program for the **development of digital and analytical talent** for all SISCAT professionals in the field.

6. Finally, to foster and generalize innovation it will be necessary to create **communities of professionals** that engage in networking, incentives for collaboration, and a process of evaluation and extension of local solutions. The relationship with universities and industry will be key to that end.

In short, we could say this is a model of **participatory governance** which must have a representative body of the service-providing entities for the strategic monitoring of the Plan, technical advisory bodies for the adoption of standards, and accreditation processes and light structures that facilitate collaboration and knowledge management in the community.

For the Plan to be effective and credible, a specific **financing framework** must be established that facilitates extension of the model and its consequences to the **framework for contracting care services**. According to the analysis we have made of experiences in the healthcare sector, among others, the financing of investments in technology in these transformation processes must be **finalist** (with incentives that favor the renovation of the technology system and its alignment with the information model proposed), **sustained** over time, and **sufficient** to fully meet the objectives in the Plan.

Therefore, and conversely, care services contracts should exclude, as soon as possible, the variable part associated with information requirements compliance, as well as the transfer of records and data other than those of the eHealth record.

It will also be necessary to review the relationship model with CTTI so that it can be adapted to the specificities of the health sector and to the fact that a very significant part of its agents and subjects of the transformation process are not bodies of the Government of Catalonia.

In this chapter we have shown the main contents of the Master Plan and the information systems model (which we have defined as coordinated and participatory) that has been proposed to overcome the current diversified and poorly governed model.

This model is based on the creation of a single longitudinal Electronic Health Record and the development of an advanced technological architecture which includes a range of valuable services for SISCAT as a whole and the provision of new care work environments for service providers who need or want to renew theirs.

The Plan establishes a process of coexistence with existing technological solutions through an approval or accreditation process.

To ensure the success of the Plan, SISCAT must have a governance model that combines executive and regulatory leadership with the involvement and advice of the service-providing entities and the creation of communities of practice for innovation development.

4

The Electronic Health Record

4. The Electronic Health Record

As noted in the previous chapters, the key element of the new Catalan information model is the establishment of a longitudinal and **person-centered** Electronic Health Record (EHR) – regardless of the professional or care provider who can process it at any given time – that is unique and used by everyone throughout the healthcare system.

The EHR will provide an integrated vision of the health and wellbeing of people and their interactions with the healthcare system (and others such as social services) and will facilitate **integrated** and **continued follow-up of patient care**. The EHR will provide professionals with **common information of relevant clinical significance** that is delivered in a timely manner and is high quality and easy to record, access, and analyze.

This tool will respect the different clinical record models of the different entities and will gradually replace the current systems based on interoperability (HC3 and IS3) and transfer of care providers' records to Catalan Health Service through multiple circuits and means.

The technological model of the EHR aims to evolve as SISCAT's integrated model of information and to incorporate transactional services which can be offered to healthcare centers, such as new professional work environments. In these cases, integration between the medical records of healthcare centers and the EHR will be natural and will not require a process of data extraction and loading.

4.1. Justification and benefits

"The medical record is, essentially, an orderly and systematized record of the clinical method, scientific knowledge applied to the clinical practice. But if practice changes, with more complex patients, new care models, more teamwork, greater importance of prevention, and new health and computer technologies, obviously the clinical record will change as well."

Specialized physician working in a hospital.

The analysis of the Electronic Health Record (EHR) by the working group (strategic initiative 1) highlights that the spread of the EHR worldwide has been aligned with the **structural changes** that are occurring in healthcare systems. First, there is a growing trend of transferring patients from hospitals to primary care settings, which has accelerated the need for efficient patient flow between healthcare providers and organizationally and geographically different levels of care. In SISCAT this is true for the *Xarxes d'Atenció Primària* (XAP) [primary care networks], stated in the *Estratègia Nacional de l'Atenció Primària i Salut Comunitària* (ENAPISC, 2017) [national strategy of primary care and community healthcare] of the Ministry of Health.

Secondly, the new operational needs of healthcare management are taken into account, such as the **information demands** of health professionals acting as the gateway to the system and the data requirements on activities by the planning and evaluation authorities.

Finally, another of the structural changes that have determined the international expansion of the EHR is the growing deployment of **shared care models**, which involve the coordinated participation of multiple health and social service providers in the same care process, one in which the patients themselves **become actively involved**.

In this respect, in addition to safe and quality care, citizens expect their personal data access and rectification rights (data subject rights) to be respected, as well as their permission for using their personal information for other reasons than those specified in the informed consent. At the same time, care providers are subject to **ethical and legal considerations** that require them to document and assess each health contact.

The EHR is a conceptual and technical evolution of the medical records that are currently stored in the information systems of the different healthcare service providers

(in primary care, hospitals, and so on), with different logics and no connection between them. The **Electronic Medical Record** (EMR) is intended as a record of the different disease episodes that lead to a consultation with a healthcare professional or center. The **Electronic Health Record** (EHR), on the other hand, reflects the health condition of a patient and their evolution over time through all contacts with the healthcare system.

Benefits of the EHR

Clinical	- Improves the quality and safety of care since it reduces errors and unnecessary tests. - Encourages transparent comparison between different care practices and the adoption of evidence-based ways of doing things.
Organizational	- Improves sustainability thanks to the reduction of erroneous codifications, the costs of paper systems, documentation processes, and the costs of coordination of care, administration, and billing. - Facilitates collaboration between professionals and devices throughout the chain of care and makes the information available to all the agents involved in a patient's health. - Improves the security and confidentiality of patient data.
Social	- Increases the ability to access and respond to changes in health and social care models. - Allows responding to new requirements and citizen inquiries and promotes patient empowerment in terms of their health and quality of life. - It facilitates carrying out epidemiological research with integrated patient data in a specific care and social context.

"Health professionals interact with patients and, from these interviews, opinions are formed. In this context, the vocabulary used in the EHR must be adapted to the symptoms, diagnoses, and conclusions so that it is intelligible throughout the value chain. Ideally, data entry systems should be useful and discrete and must incorporate speech and handwritten text recognition in addition to the standard forms and standardized templates. Otherwise, doctors will waste a lot of time coding health contacts and spend more time at the computer than with the patients."

Conclusion by one of the Master Plan deployment stage working groups, November 2017.

The EHR will also consider the need for other **uses, users, and roles** (managers, evaluators, epidemiologists, and researchers) and will enable the integration of new information sources (social, public health, or those that the patient can enter themselves) and new formats or devices (e.g. videos, biometric sensors, or direct data entry from electromedical devices).

This common health record solution must take into account and align **process** components (how citizen events and journeys through the healthcare system are created and entered), **data** components (a shared structure and nomenclature), and a **technological model** (how data is recorded, stored, and transmitted).

4.2. The data model

The central component of the new Electronic Health Record (EHR) is a unique and common **data model** that will be used by all SISCAT stakeholders for the registration, storage, exchange, and processing of health-related information (as well as common administrative information). This data model includes:

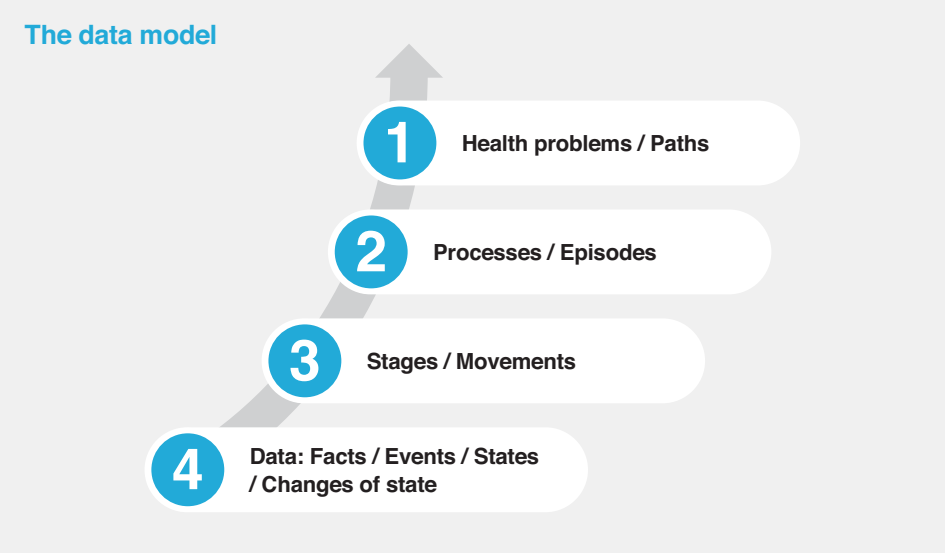
- Data **objects** or structures.
- Rules of governance to ensure **integrity** and **security**.
- **Rules for handling** data loading and consultation.
- **Accepted semantic standards** (dictionaries and catalogues).

A particular feature of the healthcare data is that they have to collect **static information** (the patient's condition at a given time) as well as **dynamic information** (the change of status, that is, the patient's journey through the healthcare system). Therefore, the data model is also a process model. From the point of view of healthcare delivery, the most relevant dimension is the **vision of the health problem**, which is structured hierarchically into problems, processes, and stages and which records information of clinically relevant events and conditions. Data are collected at each point in that process. These four levels allow keeping a vision of the healthcare actions provided and those planned.

"If healthcare is a collaborative effort between different professionals and levels of care delivery, it is imperative that these professionals and levels share the same information system."

General Practicioner.

Progressive representation of the data model



For these shared processes to be feasible, the flow of information must reach all the stakeholders involved in the value chain, both within the context of the healthcare and social care sectors, among others. This information will allow them to make better decisions in the aiding citizens.

Electronic Health Record access profiles

Health professionals

- Healthcare professionals
- Social care professionals
- Third-party care providers involved in healthcare processes
- Health administrative assistants
- Private practitioners
- Social Security's occupational injuries and diseases insurance companies
- Pharmacies

Labour, Social Affairs, and Families

- Social workers, social educators, etc.
- Third sector: volunteers, paid caregivers, etc.
- Care homes

4.3. The Eletronic Health Record Information System

The new Electronic Health Record (EHR) solution must make a qualitative leap in the provision of functionalities and services to most care providers and professionals as well as to the healthcare system as a whole and its relationships. With the services and value features it incorporates, EHR deployment must place the health information systems of Catalonia among the best in the world.

The expected EHR functionalities are detailed in a generic way as identified by the working group:

- **Management of access to data privacy rights (data subject rights).** A specific development is required that allows citizens to more easily control who accesses their data while exercising the entire set of data subject rights established by law, provided that it does not detract from patient or professional safety.
- **Transactional capacity.** An excellent opportunity to build a transactional system that works on the unique data model has been identified. In this way, the request for write access beyond read-only access by healthcare professionals currently interacting with the HC3 has been resolved. The system could serve, at the same time, as an ordinary medical record history system for organizations that cannot afford to maintain and/or upgrade their current system.

- **Online collaboration platform.** This platform must allow modelling and implementation of shared care provision processes (in line with what is currently being done with the IS3 or eConsultation) and become the standard for shared ambulatory processes.

- **Notifications.** These notifications should be generated on the unique data model by using all the information available to facilitate provision of the care service. In addition, it should be possible to parametrize notifications by profiles and reach professionals in different ways (via text message, email, the EHR itself, integration with their clinical workstation, and so on).

- **Communication tool.** Professionals interacting via the EHR must be able to interact regardless of their profile, both among themselves and with citizens.

- **Integration of the citizen's personal data.** When a professional deems appropriate, viewing and integration of the data collected by the citizen must be allowed either through the personal health folder or telehealth and mobility health applications.

- **Service layer (API).** In line with the objective of this Master Plan on generating innovation spaces, different APIs for accessing the information contained in the unique data model should be developed. In this way, professionals, service providing entities, and industry can develop innovative services around the EHR.

- **Advanced search system.** A semantic system is required to easily find information about a citizen or other fields or literal expressions within the EHR.

- **Integrated intervention plan.** All the people involved in shared care processes (professionals and non-professionals) must share this plan. The idea is to improve the quality of the information available at all levels and thus obtain better health outcomes.

- **Integration of information given by the patient about complementary therapies.** Access to the information provided by patients regarding the benefits of complementary therapies that are not included in the Catalan Health Service catalogue must be allowed.

- **Integration of information from other healthcare systems.** Patients who come from other healthcare systems should be able to provide their information for integration into the EHR of Integrated Public Healthcare System of Catalonia (SISCAT).

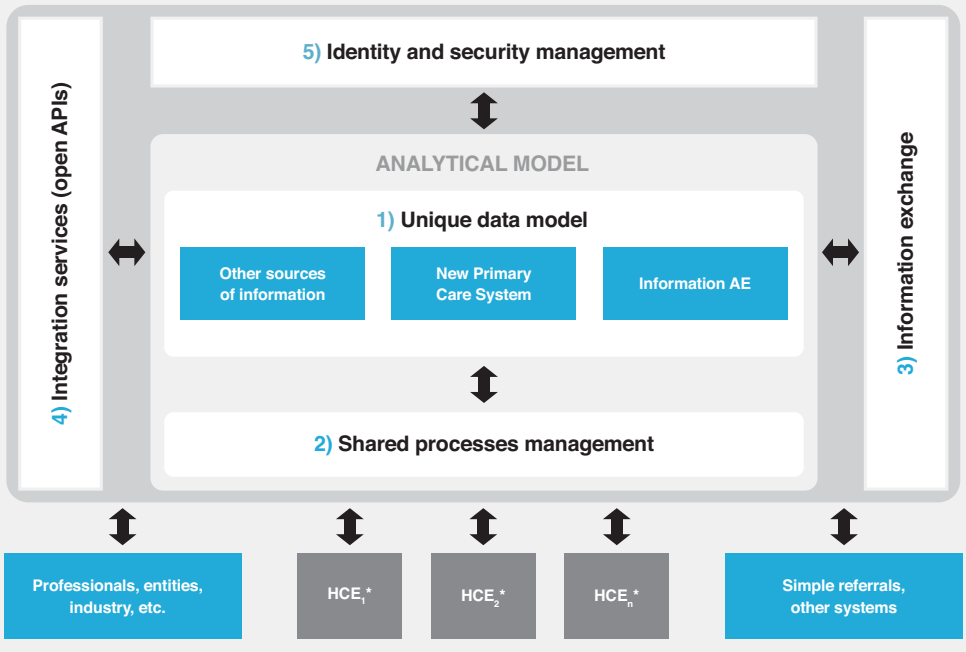
- **Citizen identification system different from the CIP.** It is necessary to process and incorporate the information of patients who are in transit in Catalonia and who do not have a health card (e.g. patients from other autonomous communities) into the EHR.

- **Integral dashboard for service-providing entities.** This dashboard must allow service-providing entities to improve aggregate knowledge and comparing health practices, activities, and outcomes.

Functional requirements of the EHR

- Management of access to personal data subject privacy rights.
- Transactional and editing capabilities.
- Online collaboration tools.
- Automatic notifications system.
- Communication among professionals and with citizens.
- Incorporation of the information collected by the citizens themselves.
- Integration of new services supplied by the industry or the service-providing entities through open application programming interfaces (APIs).
- Semantic search tools.
- Support for integrated intervention plans.
- Incorporation of information from alternative or complementary therapies.
- Incorporation of information derived from other healthcare systems or the private sector.
- Citizen identification with identifiers other than the Catalonia health card.
- Integrated dashboard available to service-providing entities.

EHR components



*Accredited medical records

An essential part of the Electronic Health Record information system is the **analytical repository**, which is made available to Integrated Public Healthcare System of Catalonia (SISCAT) to facilitate the analysis of large amounts of data with reduced response times.

"One of the objectives is that head office service units do not have to resort to health service providers for information and can go to the EHR data repository directly."

A manager in the Ministry of Health.

The analytical repository

The repository has **analytical tools with different degrees or levels of sophistication** that allow several actions, such as creating reports and dashboards, conducting searches and queries of any field that has been indexed, making multidimensional analyses, or creating alerts, recommendations, and tools to help clinical practice based on Artificial Intelligence.

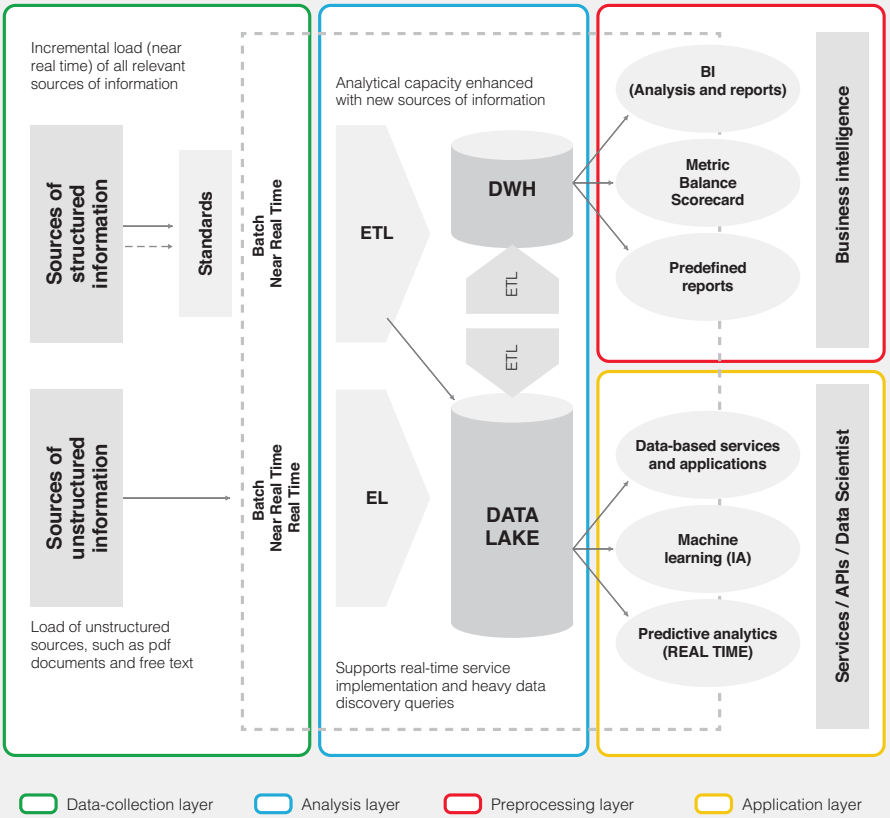
The repository will be gradually fed by **sources of information** on public health, mental health, or social care, and unstructured data related to text, image, or social networks.

Technologically, it is an **advanced repository model** that allows working in environments of classic data universes or with non-relational databases.

In the healthcare sector, unprocessed data repositories and elaborated data repositories are **converging very quickly**. Consequently, conventional analytics based on elaborated data stores and advanced analytics based on unstructured data and discovery techniques are articulated in the same technological architecture.

High-level architecture

Adapted and built for each information need



A more detailed description of the model and its applications can be found in the section on big data in the following chapter.

Finally, it is essential that citizens are offered a multichannel environment in which they can interact in real time with the systems for managing and maintenance their health, interact with care and administrative services, and handle formalities. Access must be ensured regardless of the specific information system through which the services are provided. Hence, to make use of these services there must be a single digital gateway which redirects citizens to the corresponding technical environment in a transparent way.

A citizen's health portal (***Espai de Salut del Ciutadà***) must be fully integrated with the data repository and the EHR process manager. In this way, citizens will have full access to the information of their clinical evolution, the state of the care processes they have been involved in, and their clinical appointment book.

The use of EHR **collaboration environment** services and **Intelligent Assistance** services will allow the design of new interaction models between citizens, the healthcare system, and its professionals. Also, citizens will be allowed to provide personal information regarding their health habits and include information from personal devices (apps and wearables).

"Citizens should be able to access their personal information through a single digital gateway regardless of the healthcare service providers with whom they interact."

Personal Health Portal working group.

Types of services accessible to citizens through their health portal

General information

- Information and system usage manuals.
- Information for carrying out procedures.
- Search engine and links of interest.
- Personalized health advice by age, gender, and/or preferences (recommendations of publications, websites, apps, etc.).
- Information on activities related to healthcare in Catalonia, especially conferences or talks that may be of interest to the patient.
- Information on how to prepare for diagnostic tests and planned surgical procedures.
- Practical information on the centers, such as schedules, phone numbers, layouts, and how to get there as well as nearby pharmacies, nursing homes, day facilities, and so forth.
- Information on emergency saturation in urgent care centers and hospitals (integrate current app).
- Systematic vaccination calendar.

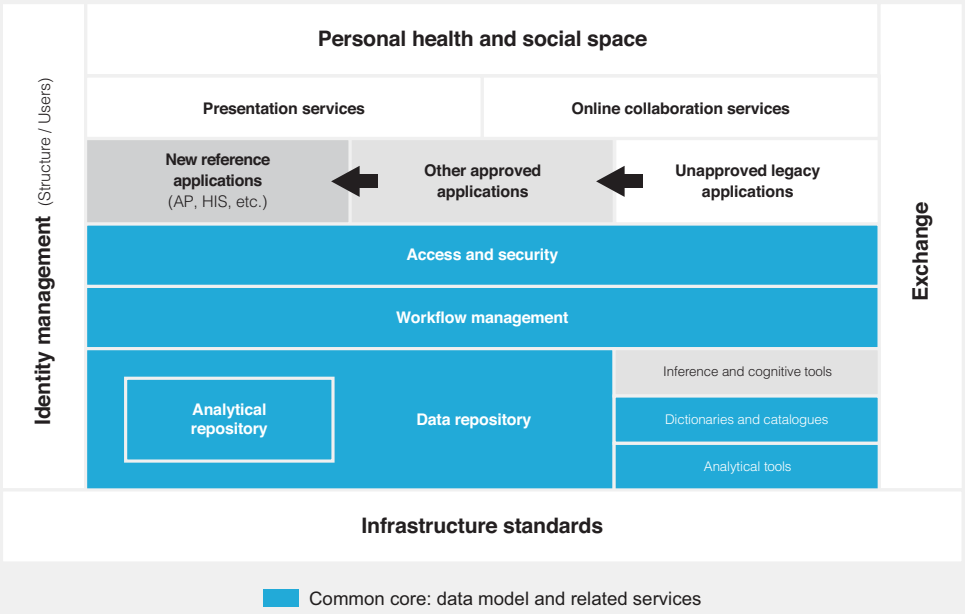
Information on care provision

- For the humanization of the health team, profile pictures of professionals who normally serve the citizen are included.
- Reports, results, and medical images.
- Social-related information (follow-up care, objectives, intervention plan).
- Electronic prescriptions.
- Notifications and reminders of vaccinations and allergies.
- Schedule of medical and diagnostic appointments and activities.
- Information on estimated time on waiting list.

As we have pointed out, the integration between the medical records of service-providing centers and the EHR will be natural and will not require a process of data extraction and uploading. For this reason, we are referring to an EHR central core which consists of the repository and related basic services (security, analytics, dictionaries and catalogues, workflow management, etc.) and a range of progressive deployment services.

For example, integration of the primary care work environment – where most health service providers use the same application – with the EHR database engine will be native, whereas a process of extraction and loading will be involved in all other cases.

Technical representation of the information model with the EHR core



"The new information system does not have to be imposed beyond data sharing. The confluence must be encouraged and will all fall into place."

Physician specialized in information systems.

In the case of specialized and social healthcare, a **process of evolution and coexistence** between different autonomous platforms is envisaged. These platforms will dump the information that is considered common in a central data repository. For this to be possible, a process of semantic and technological standardization is required.

From the normative point of view, it is envisaged that the approval of medical records and workstations of the different suppliers will be carried out through a similar **accreditation** process or one which is included in the current accreditation model of the healthcare establishments. From the organizational point of view, it is proposed that the governance of the Integrated Public Healthcare System of Catalonia (SISCAT) information systems should include a **Standards Office** and an **advisory board** with care provider representatives.

4.4. Data privacy and data security

The Catalan Information Systems Master Plan, and especially the design and deployment of the new Electronic Health Record (EHR), is both an opportunity and an obligation to work even more carefully on the fundamental right to data protection. Besides, the deployment of the program will also coincide with the implementation of the **new European directive** in this area. The working groups on the Electronic Health and Security Record have defined general criteria and provisions in this area.

The **principle of security** implies the duty of those responsible for carrying out the actions necessary to protect personal data from the risks arising from their processing depending on the nature of these data, as well as to ensure security and avoid unauthorized alteration, loss, access, and processing of these personal data.

These actions are not only technical, but also organizational. Security and privacy are related. In fact, security must be applied to everything related to data processing: treatment centres, premises, equipment, technical infrastructure, and software.

"In addition to safe and quality care, patients expect their privacy and rights of access and rectification to be respected, as well as the ability to consent to the use of personal information for research purposes."

Conclusion by one of the deployment stage working groups, November 2017.

Classification of security measures

1. Organizational
2. Related to users
3. Related to the use of information (information life cycle):
   - 3.1. Collection
   - 3.2. Recording
   - 3.3. Storage
   - 3.4. Processing or treatment
4. Transfer
5. Storage
6. Destruction
7. Related to situations outside the usual processing
8. Related to exceptional situations

The fact that the Electronic Health Record (EHR) is a systemic approach (that is, it includes data, processes, and technologies across the entire healthcare system with a much higher and varied number of uses and users) calls for the development of an integrated **Security Plan** such as those developed by companies and complex organizations with multiple plants or work centres. This plan will identify the initial risks and the impact of the new processes and data processing and establish the series of actions to avoid or minimize these risks.

The care providing centres will be responsible for some of these actions, which will be formulated in terms of recommendation or as normative for their accreditation. Other actions will correspond to the bodies responsible for EHR as a common service of the healthcare system.

Dimensions and technologies to bear in mind in the Security Plan

Privacy

The privacy strategy must be supported by different technologies to prevent undesirable access to sensitive information. This strategy must respond to two dimensions:

- **Encryption.** Sensitive data encryption methods should be defined. Those responsible for data safeguarding will have to identify and control the encrypted data. A specific security team will have to manage encryption and decryption passwords.
- **Masking.** To ensure protection of sensitive data and prevent its identification, its content must be modified while its structure and consistency is maintained. Two types of masking strategies can be performed:
  - Before using the piece of data, mask it according to the users' roles.
  - Before serving up data, prevent them from being delivered without masking.

Security

The security strategy must respond to the following dimensions:

- **Authentication.** Users who use the analytical platform will have to be authenticated.
- **Authorization.** Once authenticated, it must be verified that the user has enough privileges to perform the requested action. This authorization can be divided into two concepts: operation authorization and authorization for access to the repository.
- **Visibility.** This dimension defines what data is accessible to the user. Visibility policies can be defined at different levels: attribute/indicator, registration.
- **Audit.** All data access must be audited for both authorized and unauthorized operations. It will be essential to define the different audit levels (logical or physical).

To conclude, it can be said that the core of the EHR will be a **central repository** of structured data that are useful to share and accessible across Integrated Public Healthcare System of Catalonia (SISCAT) through a secure permission system. For this reason, EHR entails a common system of medical information and documentation management and acts as a cross-cutting platform to share healthcare information between different centres and health professionals. In this way, it improves the care process and provides information and security to clinical and social care.

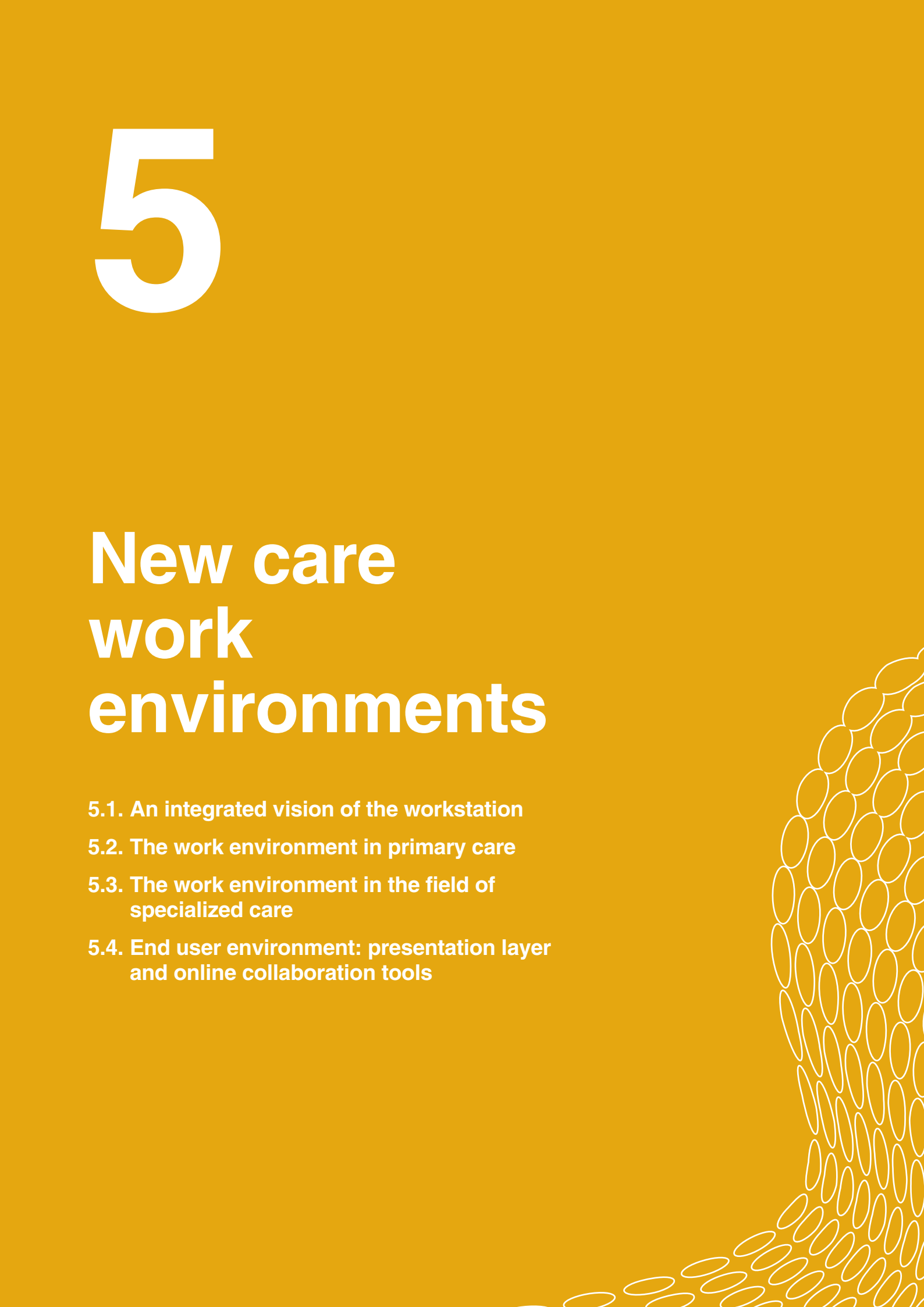
Technically, the data repository is an **advanced model of information management** which allows the near real-time processing and analysis of large amounts of information from different sources and formats. Both tools and data products are made available to the different service-providing entities.

Hence, this is not a model of uniformity. Instead, it is a model of **compatibility and coordination** that returns value-added services to the care provider. In fact, some care providers of integrated services with a territorial scope have already developed platforms with these features, which are included in the annexed material of the Electronic Health Record working group.

It is envisaged that the EHR will evolve as an **integrated information system**. Therefore, it must include new work environments and transactional services, which will be offered to the service-providing entities requiring them either at present or in future. In the short term, this will be the case for **primary care**, as most care providers use the same workstation. The next chapter presents the actions envisaged for the Plan in relation to clinical workstations.

5

New care work environments



5. New care work environments

As mentioned in the previous chapter, the information systems model developed around the Electronic Health Record (EHR) aims to evolve into an integrated Integrated Public Healthcare System of Catalonia (SISCAT) information model with the incorporation of transactional services such as **new professional work environments** in the different healthcare areas (primary, specialized care, mental health, social healthcare, etc.) and departmental services (laboratories, pharmacy, and mental health). All these services can be offered to the care providing centres.

In these cases, the transformation will not involve a process of data extraction and loading since the medical records of the healthcare centres will be integrated into the EHR in a natural way. Just as the longitudinal Electronic Health Record record is a single, common record across Integrated Public Healthcare System of Catalonia (SISCAT) and is organized around a central repository, the evolution towards all other services is progressive and is offered to those healthcare service-providing entities requiring such use either now or in future. On this matter, a faster process of primary healthcare systems unification and on the other hand, a homologation process of specialized care information systems are envisaged to ensure compatibility with the EHR.

5.1. An integrated vision of the workstation

"If there is already an integration of care in Catalonia, at least with respect to specialized outpatient care, it makes sense for professionals to use the same tool when they move from the hospital to the primary care context."

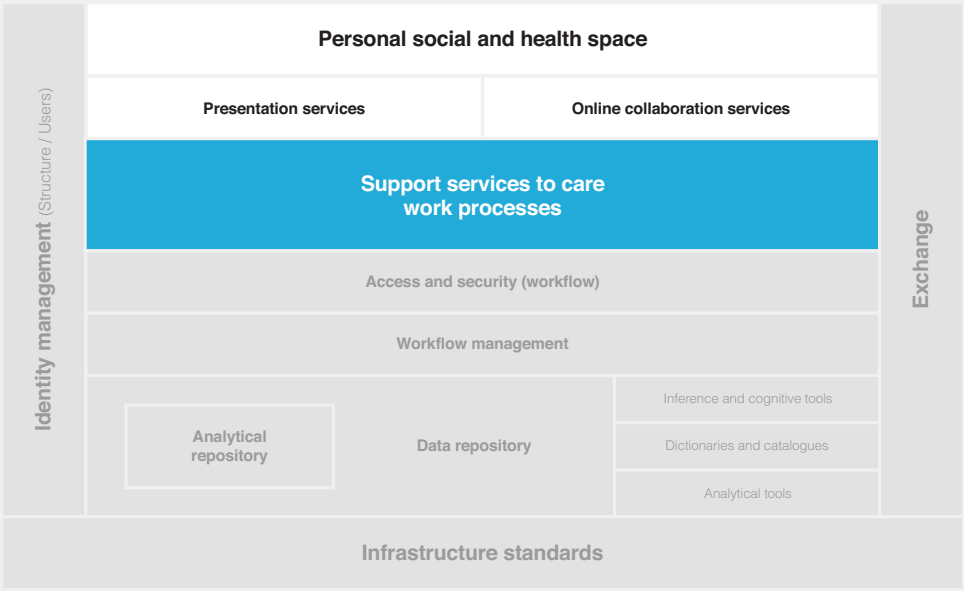
Hospital physician.

We started to see the evolution of care models, initiating with the integration of regional services or through collaboration by hospital professionals in the field of primary care or in social care. Such examples evince many basic functionalities of clinical and nursing workstations must be common, at least in out-of-hospital contexts. Therefore, we think that it makes sense to envision a common workstation (business logic and presentation layer) that has different modules specific to each level of care (for example, vaccination modules or health plans in primary care or hospitalization and operating rooms in specialized care).

The work environment consists of specific transactional services. Some of these services may be common to different types of professionals (doctors, nurses, social workers, etc.) and healthcare settings (primary care, specialized care, socio-healthcare, etc.).

In this vision, the new work environment will use the technological services of the system and the presentation layer, which will be common.

Work environment architecture



This approach, however, requires thorough reflection and involves a difficult change management process which has not been added to this already complex Plan. Therefore, in the initial work carried out by the working groups deploying these strategic initiatives, the conventional logic of dealing differently with services (applications) that support **primary care** and services (applications) that support **specialized care** has been maintained, although the layers of access and presentation may be the same or very similar for all Integrated Public Healthcare System of Catalonia (SISCAT) professionals.

5.2. The work environment of primary care

A care process typically begins with primary care. In any case, it is the **environment for monitoring the health condition** of a citizen and the sphere for developing personal and community **prevention** actions.

It seems logical to give priority to this level of care in the design and creation of the longitudinal Electronic Health Record (EHR) , since this tool, which is based on the condition and health process of the patient, becomes the central element of the information model. The process can also be matched with the redesign of the AP Clinical Workstation. In this way, it is easier to integrate into the model episodes of intensive care and hospital admissions, which have a different logic. Anyway, professionals from the field of primary care, specialized care, and socio-healthcare must be involved in the design of the data model from the start.

The new primary care environment must support the entire network of primary healthcare and community health and integrate information from the **common data model**

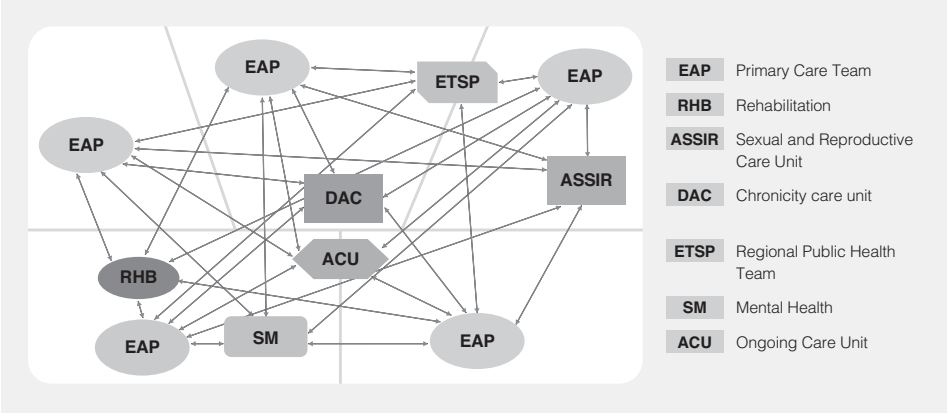
"Interestingly, in the case of primary care support tools for work processes, they are being shared on 92% of the network (this would be a 'unified' model). Despite this, due to the features of the database, which is based on the concept of 'quotas' or groups of patients assigned to each physician, data cannot always be shared, not even within the primary care team. We must move from quota logic to team logic and from team logic to system logic."

Member of the strategic initiative for primary care working team.

between healthcare levels, **healthcare**, and **social care** providers, as well as **Public Health** information and municipal social services. It must also be common to all professionals and managers who are involved in this environment.

Area of application for primary care

ENAPISC [Catalan strategy for primary care and community health of the Ministry of Health] defines the primary care network (XAP), which is the area of the primary care work environment, as the conjunction of primary healthcare service providers, mental health centres, social care homes, and other support services to Primary Care Teams (EAP) operating in the community.



The new primary care work environment can be thought of as an **evolution of the current** Clinical Workstation for Primary Care, called **ECAP**, which is the result of years of accumulated knowledge and expertise of the system teams that have developed it). Having said that, the new primary care work that incorporates a series of improvements aimed at supporting the healthcare process and usability, in addition to other developments in interoperability, data integration, and analytical uses, which will be provided by the EHR itself. One could say that it is a **reverse engineering** process.

Reverse engineering

Reverse engineering is the process that seeks to obtain information or a design from a product in order to determine its components, how they interact with each other, and what the manufacturing process was. Currently, the products that most frequently undergo this method are precisely computer programs and it is widely used in the development of products based on free software.

The method is called this because it works through the engineering tasks in the opposite direction. These tasks commonly involve the use of technical data to produce a specific product. In order to apply reverse engineering, it is necessary to further study the product and how it works so that one can understand, modify, and improve its operation, usually with the use of more advanced technology.

Regarding the improvement of support for the care process, whether it is in-person or delivered remotely, one of the elements to be developed is the services that accompany the **segmentation of demand** according to needs. The population is currently segmented by morbidity, but this classification is not automatically transferred to the healthcare agenda. The logic and experience of professionals tells us that in the face of different demands, supply should also be different. The **adaptation of agendas** would improve the time management of in-person care and personalize care provision according to the patient's needs.

Likewise, the new environment must make communication channels, **connection with telehealth solutions**, and access to the resources of the healthcare system in mobility available to professionals and patients. This new environment must integrate the current initiatives of eConsultation, eXat [eChat], and WhatsSalut [WhatsHealth] and develop new **online collaboration tools**.

With the evolution of ECAP, the application will have a **modular architecture** which includes specific services for different types of needs, such as nursing homes, non-emergency home care, occupational health, or outpatient mental healthcare.

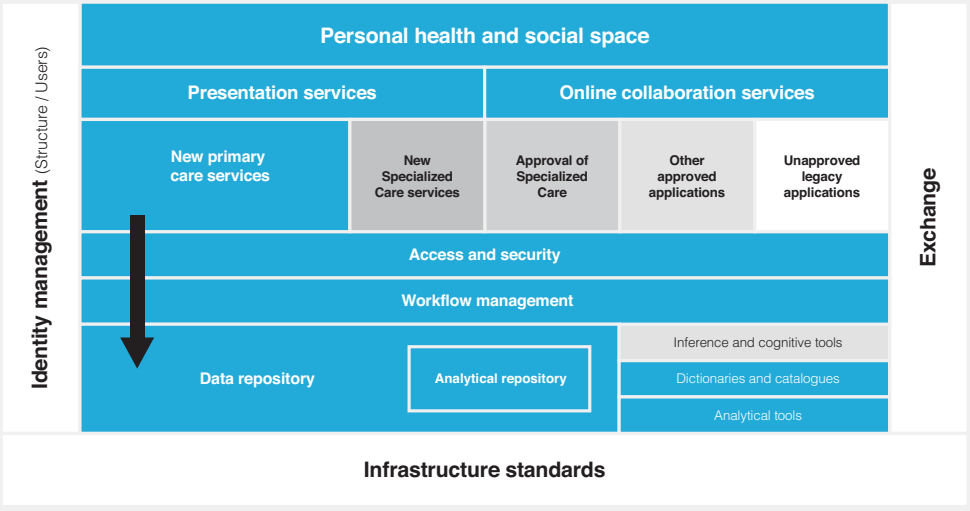
Finally, the **process management** tool ensures the integration of care processes with other external information systems and the services integrated into the EHR (analytical, Telehealth, and Mobility services, Artificial Intelligence, or the Internet of Things) as they develop.

In short, the primary care system will be the first to adopt the suggested architecture of the EHR as an **integral information system**. The various components of this system will be fully developed, such as, for example, the terminology manager, automatic alert systems, and rules of inference to facilitate diagnosis and treatment.

"When designing the Electronic Health Record we must have the ability to use two different logics at the same time. On the one hand, it makes sense to dump the huge amount of information that hospitals are sending in the common data repository as soon as possible (reports from the HC3, the CMBD, the RSA, etc.) and promote it. On the other hand, the conceptual design of the repository must start from primary care while keeping in mind the features that the hospital will need."

Hospital Managing Director.

Relationship between the Clinical Workstation of Primary Care and the EHR



5.3. The work environment of specialized care

"The heterogeneity of HIS systems implanted in Integrated Public Healthcare System of Catalonia (SISCAT) hospitals makes it very difficult, if not impossible, to meet equity criteria: different degrees of solutions for the same problems, different degrees of insight and contribution to the patient's electronic health record, different degrees of investment in maintenance and improvements."

Member of a deployment stage working group.

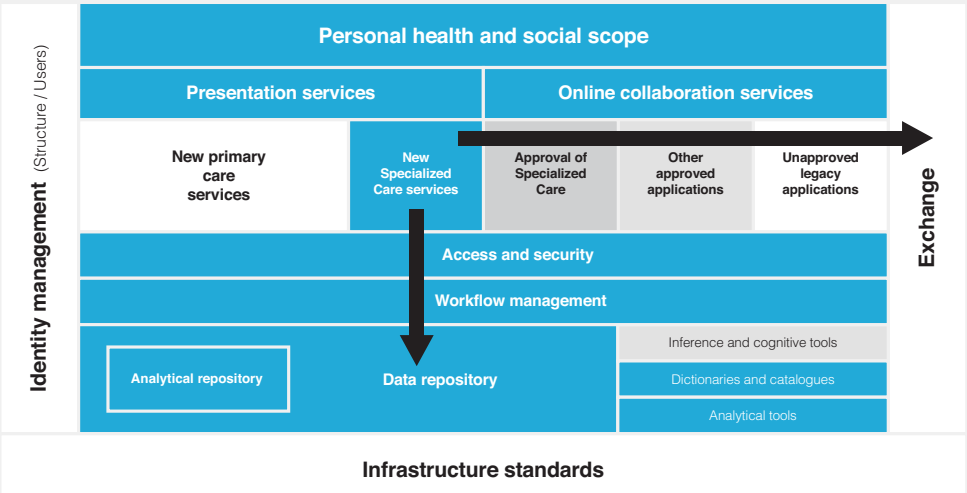
We refer to **vertical hospital management solutions**, which is popularly known as HIS (Hospital Information System). As said in the previous chapter, the EHR seeks to be a comprehensive information system. The idea is that, like in the case of primary care, the EHR can complete the "core" system (the longitudinal medical record) alongside other transactional, modular, and parametrizable services according to the needs of each care provider.

The new reference environment may be either tailor-made or an adaptation of a manufacturer system provided it meets the technological standards, principles, and values of Integrated Public Healthcare System of Catalonia (SISCAT) ICT management. This analysis has not been tackled by the working group that has developed this strategic initiative and will be addressed within the framework of the Executive Program for the implementation of the Master Plan.

Care providers may opt for this solution whenever it is made available. In the meantime, existing technological solutions will be approved to ensure their compatibility with the "core" EHR (the longitudinal eHealth record, which includes the data repository, the semantic rules, and the workflow manager). Each care provider will **keep their medical record** with the data they deem appropriate, but, in any case, they will have to use and share the data, dictionaries, and codes common to the EHR.

In the case of care providers that use the new reference HIS, as is the case of primary care, integration with the EHR is native and in real or near real time, and they immediately benefit from the remainder of services implemented in the information model. As for approved applications, a **data integration platform** will be used (an improved evolution of the current IS3) in push mode (automatic information uploading).

Relationship between Specialized Care and the EHR



The current facilities are based, in many cases, on monolithic technology models and proprietary manufacturer models, to which specific functionalities have been added through a large number of integrations developed specifically at the customer's office or by an external care service provider.

The current technological evolution makes it possible to propose more **modular**, **uncoupled**, and **interoperable** application models, both functionally and technologically, that can be executed in distributed process environments or even in the cloud. The fact that these modules follow a set of definition, development, and/or communication **technological standards** can allow **cooperative development**, reusing developments among professionals from different entities, and increased participation with local companies.

The new reference HIS will therefore not be one of the systems currently implemented. However, the current systems will have to undergo a process of approval to ensure compatibility with the EHR and, desirably, a process of convergence between solutions by the same manufacturers.

The development of support services for specialized assistance activities within the framework of the EHR, particularly the **workstation of doctors and nurses**, must be oriented towards the latter type of architecture. This approach will also allow the incorporation of specific functions in legacy information systems.

"Implementing the new HIS has been tough, but the project and the solution seem satisfactory to me. What we have not addressed are integrations with in-house and other external applications, the information management layer, and I also think we are too dependent on care providers."

Regional manager.

Objectives of the technological renovation of the specialized care work environments

- Achieve the strategic objectives of the new information systems model: patient-centered with a full vision across Catalonia, processes, integrated care pathways, etc.
- Integration with the data repository and its related services ("core" EHR).
- Have a modular, decoupled, and scalable HIS solution.
- Full integration in the single EHR repository.
- Achieve a technological leap adapted to needs.
- Share human and economic resources and obtain economies of scale.

The HIS strategic initiative working group has identified the basic **functional and technical criteria** that must be met by approved solutions and the new reference solution, in addition to those that will be common and part of the Electronic Health Record (EHR):

- Respond to the needs of all professionals involved in patient care and adapt to the workplace and role.
- Adapt to different organizational models and environments.
- Process of records, conditions, and chronology based on the concept of altered health conditions caused by the patient.
- Incorporate types of care planning (clinical guides, protocols, pathways) with exception management.
- Information on a hospital's structural resources and equipment (availability, use, etc.).
- Ability to register any material or resource used by care providers.
- Manage alerts and alarms in certain patient situations. Getting EHR alerts or sending out alerts.
- Registration and processing of data that are not necessarily part of the global data

model, such as custom data collection forms by a professional or a service.

- Ability to define and process population subsets and add proactive functionalities to monitor these subgroups.

- Ability to interoperate in real time with the EHR data core.

- Multimedia capabilities.

- Modularity to allow the necessary functions of a technological solution to be used in each case.

Additionally, and as is already expected, hospital systems will have to meet the standardization requirements that ensure compatibility with the EHR. These are, among others:

- Unique identification of the patient throughout Integrated Public Healthcare System of Catalonia (SISCAT)

- Homogeneous coding of the healthcare activity included in the EHR.

- Control systems to ensure data quality.

- Incorporation of in-house or EHR support systems for decision-making.

- Alignment of patient data privacy management with the policies defined for all of Integrated Public Healthcare System of Catalonia (SISCAT) and in accordance with the law.

- Incorporation of the multi-channel communication functionalities with the patient according to the defined standards.

5.4. End user environment: presentation layer and online collaboration tools

"The system must be a utility for both healthcare professionals and managers. The usability must be designed on a day-to-day basis and must allow professionals to save time."

Integrated service provider manager.

The presentation layer and the collaboration tools will be the main interface (front end) for the different system users (professionals, managers, and citizens). The purpose of its definition is for users to have a **homogeneous** and usable **image** of their work environment, regardless of where they log on from and the means they use to do so.

A system user should be able to identify, despite working with different care provider systems, a menu structure, options, and similar browsing systems. If a professional works with the same system, they would have to have **functions relevant to the role** that they undertake at all times, allowing customization of the work environment. This approach includes mobility tools and apps.

When we talk about this presentation layer, we refer to a series of design criteria and technological standards (i.e. frameworks) for workstation environments and mobile apps. These elements have different objectives:

- Increase user/customer **satisfaction**, **productivity**/efficiency, and **adoption** and **use** of different services/systems.

- **Simplify interactions** with the computer system and minimize the need for professional care and time devoted to technology so that patient care can be maximized.

- **Reduce development** and **maintenance costs**: only necessary functionalities are developed and adjusted to user needs.

- Reduce the needs and **costs of training**, **support**, and incident resolution.

Elements of the presentation layer

- **Design and usability guide**, which will define the elements common to all applications, both graphic and operational:
  - Common components in authentication processes.
  - Design and typology of homogeneous content menus.
  - Distribution of health information in tabs/ sections/etc.
  - Type and operation of data entry fields.
  - Homogeneous components to identify common actions (for example, buttons, shortcuts, etc.).
  - Maximum number of clicks to access health information.
  - ...
- **Technological standards** that allow sharing and reusing developments and integration in the workplace of the services provided by EHR.
- Have at least a basic **workstation infrastructure**.

"When we talk about user-centered design, we mean a much broader concept than a relatively ergonomic presentation layer. It is the designer who should keep in mind the work logic and the user experience throughout the development cycle of a system. It is a point of view and a work methodology."

Expert from one of the deployment stage working groups.

The Master Plan proposes the development of a **Workplace emergency action plan** to improve and update the conditions of both fixed and mobile work environments.

Workplace emergency action plan

The strategic initiative working group dealing with the needs of a technological infrastructure action plan proposes a first classification based on the following areas:

- Location of the workplace.
- Mobility.
- Type of professional who uses it.

Other aspects (e.g. how critical a workplace is) will allow us to define parameters related to the computer support service, such as the standard service level associated with an incident in a critical workplace.

In addition, it will be necessary to ensure the necessary **data transmission capabilities** in mobility or in social and health centers to be able to make use of all digital services that will be more critical in future care models.

"We need domestic collaboration tools integrated with our work tools that are safe. We must also work on the incorporation of workstations on tablets and mobile devices."

Comment at the participatory event, July 12, 2017.

When the use of **common technological standards** is widespread, the work environments of a care provider may use, in addition to EHR services, developments made in collaboration with other care providers. This definition envisages the use of market standards so this collaboration can be extended to **local industry**.

An element related to the presentation layer is that users have **secure**, synchronous, and asynchronous **collaboration tools** for text, voice, and file sharing of documents and images. These tools are very similar in functionality and appearance to those used in a non-professional way in everyday life. The environments must be secure and collaborative, integrated with applications, and auditable (leaving evidence of their uses), but agile enough to generalize their use.

In this chapter we referred to the renovation of work environments to facilitate integration with the digital Electronic Health Record (EHR), but also to increase its functionality, facilitate technological evolution, and streamline the existing legacy system.

Some of the current systems, such as the main workstation in **primary care**, require a thorough technological modernization. This is also a good opportunity to design the new data model and the common repository.

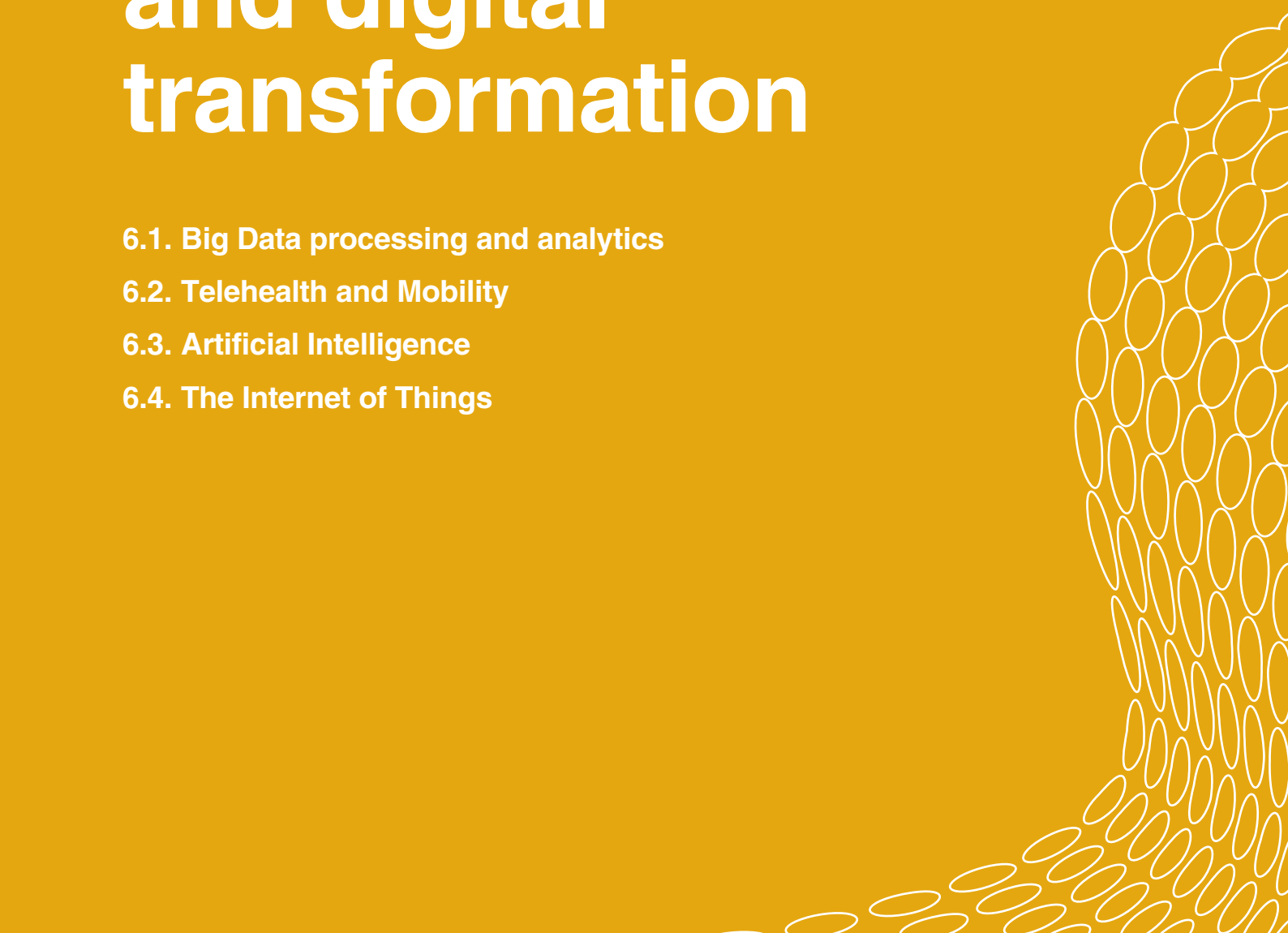
The workstations at some **hospitals** have only been recently implemented, but they are already consolidated and will only need a short-term accreditation process that makes them compatible with the new EHR.

The new **clinical workstations** (the new ECAP or the new HIS, different from the ones currently in place) are integrated naturally and in real or near real time in the EHR information model and the common data repository. **Approved workstations** will use a data integration platform.

The design of the new information model will incorporate **user-centered design principles**, which will be particularly noticeable in the presentation layer. Additionally, the model will incorporate **secure online collaboration** services among professionals and between them and the patients.

6

Innovation and digital transformation



6. Innovation and digital transformation

"What we call 'digital transformation' would be the 'third wave' of digitalization, the massive use of data and new technologies."

Working group.

In health, like in other economic sectors, information technologies have traditionally been considered as tools to support operations or work processes. In recent years it has been recognized that the development of some specific technologies in a hyperconnected world is transforming the way we work and the relationships of health organizations with and between patients and professionals. This process of intensive health information and ICT use to transform entire industrial organizations or sectors is known as **digital transformation**.

The digital transformation of healthcare is possible with the confluence of a series of technologies, whose characteristics and applicability we will review in this chapter. This confluence of technologies allows improving or even transforming the processes of prevention, care, and management and also promotes a more personalized, transparent, ubiquitous, and continued care delivery.

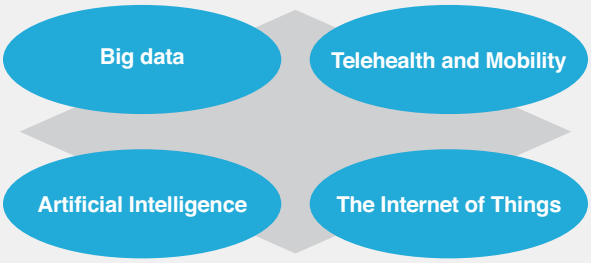
This chapter is not an exhaustive analysis of all the technologies available for digital transformation, but an initial review of the most significant ones – with experiences and applications more directly related to the healthcare sector – and a more obvious integration with the information model that is proposed in the Master Plan, which is based on the Electronic Health Record. We will focus specifically on big data, Telehealth and Mobility, Artificial Intelligence (AI), and the Internet of Things (IoT).

These technologies are optimally exploited within **a global technological framework** such as the one proposed by this Master Plan. For example, the Big Data analytics tools will make use of AI techniques to extract health information from the EHR repository, which will include information from medical devices (IoT) in the patient's home and will be accessible from mobile devices (Mobility).

Integrated Public Healthcare System of Catalonia (SISCAT) has been a pioneer in the development and application of such innovations, particularly in the field traditionally called telemedicine, through local initiatives and public agencies and in collaboration with universities and industry. Despite this, SISCAT has not been able, in general, to extend their use effectively.

The main objective of the Master Plan in this area is to provide the **critical mass** and economic dimension necessary to allow the growth and exploitation of innovation throughout SISCAT.

Key areas for digital transformation in the Catalan Information Systems Master Plan



6.1. Big Data processing and analytics

As explained in Chapter 4, the data repository with analytical objectives is **part of the EHR data repository**. This warehouse incorporates data from **healthcare** processes and resources, data from different types of **devices** (medical technology or patients' own devices), and **external data** from other sources of health information, both from public administrations (public health, social services, justice, or education, among others) and from open networks (social networks, public records, and, in general, open data) and in **different formats** (image, audio, text, sensors, etc.).

In this section we will refer to the specific tools that allow us to respond to the need to process and manage large amounts of data to obtain health information. This information will be useful for analytical processes, to **support decision making**, and for the generation of **data-based products and services**. New scalable system architectures and new data processing and analysis tools are defined to support data **exploration** and model discovery, ad hoc analysis of different levels of complexity, management and monitoring reports, as well as real-time data analysis.

Big Data use in a real context such as Integrated Public Healthcare System of Catalonia (SISCAT) allows relatively simple analytical uses (dashboards, reporting, comparison between care providers and professionals, etc.), more sophisticated ones (identification of risk factors, prediction of epidemic outbreaks and programming resources to tackle them, improvement of clinical and pharmacological guidelines, analysis of treatment compliance, improvement of financing models, etc.), and the Artificial Intelligence algorithms discussed in a later section. Big data use also allows for analyses and provides answers in real time.

Currently, SISCAT generates an extraordinarily large amount of data daily related to health conditions, diagnoses, images, and treatments. Considering this situation and the expected growth in the amount of data, traditional relational database systems are reaching the limit of information processing in the time and form necessary to become a real support for management and care-based decision-making at an acceptable cost. To get the most out of this, new scalable system architectures and new data processing and analytical tools are needed. Both the architectures and tools must support data **exploration** and model discovery, ad hoc analysis of different complexity levels, management and follow-up reports, and real-time data analysis.

In order to respond to the needs of structured and unstructured, historical and real-time, and aggregate and detailed information management, the proposed model is a combination of concepts and technologies from the **Data Warehouse** and **Data Lake** that will include a wide variety of processes and analytical tools.

"Health is an information and knowledge business. In our case, it must allow us to compare efficiency and effectiveness and approach the purchase of evidence-based health outcomes."

A Catalan Health Service manager.

"The main objective of information systems is to provide health information, both to healthcare providers and to the Ministry of Health, for clinical care, planning, and management decisions. It will be necessary to have information on everything that could jeopardize the health of an individual and the use that this individual makes of health and social services."

A specialist physician working in a hospital.

Data Warehouse and Data Lake

Today, the amount and type of data and the way the data are produced, processed, and stored is completely different. The data collected today both inside and outside organizations take up a **huge amount** of storage space, are produced in a continuous **flow**, and come from multiple sources (social networks, sensors, mobile devices, web clicks, etc.) and in many formats (image, documents, etc.). Above all, these data can no longer be stored only in rows and columns (as was done in traditional relational models) because they have a **different structure**. More so than the size, the nature of the new data flow is different and therefore must be worked on differently than it was in traditional data analytics.

The Master Plan proposes a technological architecture called a Data Lake that allows working directly on the database repository (the transactional repository), adding semi-structured or unstructured information in multiple formats, and creating conventional data warehouses, as well as different structures and analyses (non-relational or not only relational and those typical of Big Data).

The objective of the model is to be able to carry out rapid, sophisticated consultations and analyses of large amounts of data in a way that would be impossible for anyone to do directly on traditional database. The model allows users to create their own warehouses and **do experiments**. The outcomes of the experiment can then be incorporated into the system in the form of new analysis models, patterns, and predictive models.

The strategic initiative working group in charge of the analytical model has carried out a very technical and detailed analysis of the features and operation of this architecture.

Functional and technical features of the proposed model

- **Functional**
  - Unified support for structured and unstructured data
  - Flexible schemes designed to adapt to frequent changes
  - Generalized for all types of information applications
  - Ad hoc queries with experimentation functions on data sets
- **Quality**
  - Robustness and tolerance to process errors and source data
  - Debugging to identify the origin of each value in the system
- **Technological**
  - Management of unlimited amounts of data management
  - Support of any processing type: interactive, Batch, Real-Time, and analytical
  - Low read and update latency (delay)
  - Extensibility of functionalities at a minimum cost
  - Horizontal scalability with limited cost resources
  - Compatibility with any type of infrastructure (cloud, hybrid)

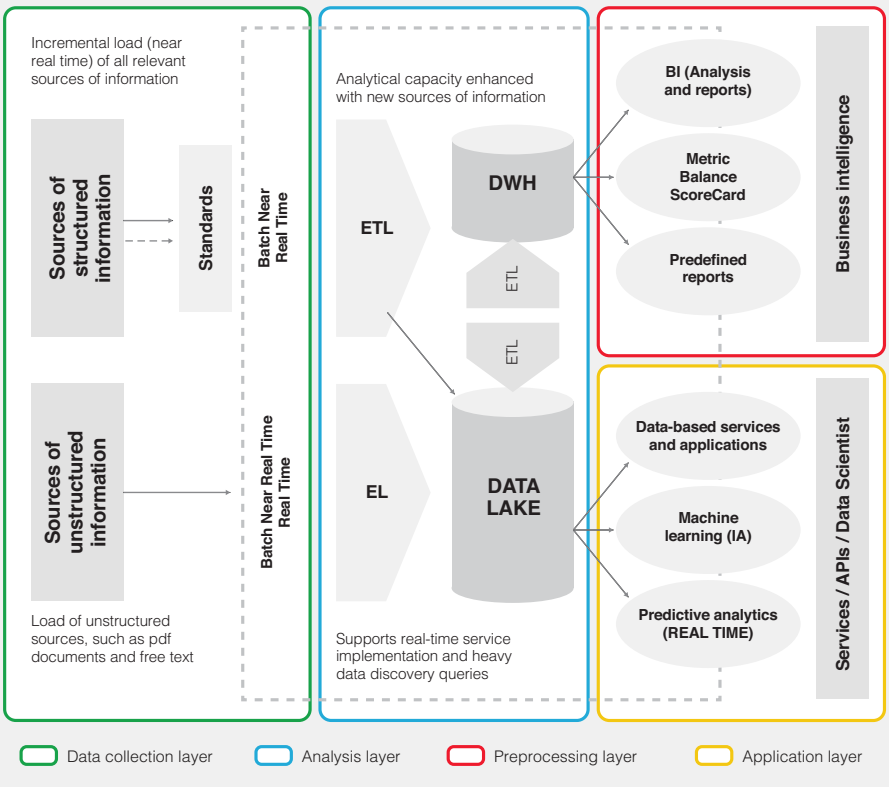
Description of the technical architecture

The proposed architecture is structured in different layers of information processing that operate sequentially:

- **Data collection layer.** This includes traditional technologies for obtaining and ingesting primary data (raw data), which can be structured, semi-structured, or unstructured.
- **Preprocessing layer.** Preparation, cleaning, transformation, and integration services are carried out in this layer. It combines differentiated strategies for processing structured data (Data Warehouse) and unstructured or semi-structured data (Data Lake).
- **Analysis layer.** Global real-time computation and storage of monitored and preprocessed data is performed, with calculation processes needed to give access to predefined visualizations of the data.
  - This layer includes services used to index and present the views from the previous layer which can be directly queried.
  - The discovery layer is also included. It consists of the experimentation layer of the repository and allows different users to work in a separate area.
- **Application Layer.** Concrete services are developed based on preprocessed data from the previous layers. A databased product consists of both the data itself and analytical processes and requires iteration and experimentation processes.

High-level architecture

Adapted and built for each information need



6.2. Telehealth and Mobility

"In the near future, chronic disease will dominate and it is necessary to be able to treat patients outside the hospital environment, at home or in an outpatient care setting. Mobile technologies allow remote patient monitoring in these settings."

Care Processes coordinator.

Telehealth and Mobility technologies favor the evolution from a patient care model based mainly on in-person care towards a model that is **not necessarily in-person**, is preventive, and is based on **ongoing care** provision, with more active participation by patients in the care process. These technologies must serve to establish **new models of care and communication channels** between professionals and citizens that are more efficient and sustainable, which allow recommending healthy habits and true citizen **empowerment** regarding their own healthcare.

Types of Telesalut Technologies

- According to the type of communications:
  - Synchronous or real time
  - Asynchronous
- Depending on the objective:
  - Remote diagnostic
  - Teleconsultation
  - Telemonitoring
  - Tele-education
  - Remote treatment

Citizens will demand more flexible care that is realized through mobile services, as is done in all other areas of everyday life (electronic banking, shopping, travel, social networks, etc.). Therefore, citizens must be offered the possibility of interacting with the healthcare system remotely, to the greatest extent possible, and **preferably from their cell phone** as this is the most widespread technology and it can easily replace other remote care tools. Although some differences are present, the same thing applies to healthcare professionals both in the field of ongoing care and in hospitals.

According to the strategic Telehealth and Mobility initiatives working group, the use of these technologies should contribute to the evolution of the healthcare model towards a more preventive and more personalized model:

- The **redefinition of care models**, with the integration of remote care in the care process. Patients should not experience the introduction of remote care as a loss of in-person care, but rather as a gain in care quality.
- **Personalized and humanized** care to move from a process model based on pathology to a model of longitudinal processes based on the patient. For example, personalized recommendations based on a patient's condition, their health record, and care alternatives.
- Focus on **prevention**. Facing an increasingly aging population, with chronic diseases and multiple pathologies, the healthcare system must focus on preventive medicine that promotes healthy habits, self-care, and personalized health information, and that is able to provide citizens with the tools that facilitate their empowerment and participation in decisions that affect their health.
- Promotion of an **active patient role** in self-care. The use of telemedicine for the collection of remotely monitored measures for healthcare professionals that could cause a patient stress must evolve towards models that are based on the active participation of patients in their care.
- **Access of emergency care teams** to vital patient data remotely and in real time.
- Incorporation of remote care and mobile care as a **planned activity for professionals.**

The implementation of these technologies must be **universal** and, therefore, initiatives

must be shared so that all healthcare providers can provide the same service. For this homogeneity or equity to be sustained it is necessary to keep in mind the diversity of technological infrastructures throughout the territory and, consequently, seek alternative solutions according to the circumstances of each service-providing entity.

6.3. Artificial Intelligence

As the working group that has developed this strategic initiative points out, **artificial Intelligence** (AI) mainly takes advantage of the data stored in the unified Electronic Health Record (EHR) and in the analytical repository and feeds them back. AI development in Integrated Public Healthcare System of Catalonia (SISCAT) would be unimaginable without the creation of the EHR. AI is based on the **construction of information-based products and services**, such as assistants for speech or writing recognition, diagnostic assistance, proposing or recommending treatments, responding to consultations through natural language, recognizing pattents and predictions of behavior, or automating control and resource planning. Although the characteristics of the sector (complexity, legal, ethical, and professional requirements, etc.) and data heterogeneity may seem barriers for AI implementation, increased development of this technology is expected in the near future.

In any case, the use of Artificial Intelligence in SISCAT is considered **complementary** and **not a substitute** for the work of different health professionals to increase the value, quality, and safety of healthcare practice.

"AI consists in the development of new products and services for assistance, which is based on big data processing. The healthcare sector is one of the sectors with the greatest potential."

Working team.

What is Artificial Intelligence? (I)

Artificial intelligence (AI) includes **a wide range** of concepts, techniques, and tools, ranging from mathematics and applied statistics to computing, psychology, and neuroscience. It aims to develop new techniques, objects, and devices capable of **replicating some capabilities of human intelligence**.

Initially, these products (algorithms) can easily replace other algorithms that are used in the development of different types of software, but they can also acquire and create knowledge and skills, recognize human speech and establish conversations, perceive, reason, and move or manipulate objects.

With the advances in computing capacity, the availability of huge amounts of data accessible in real time, and the development of theoretical and applied research, AI has undergone great advances over the last few years in the technology industry and in many other economic sectors, including healthcare.

What is Artificial Intelligence? (II)

Characteristics of IA techniques

Cognitive Computing	Cognitive computing systems are able to interact naturally (with natural language) with people, learn from the data they have access to, use reasoning for a certain purpose, and incorporate the result of their reasoning, that is, learn through the interaction experience.
Machine Learning	Algorithms built on mathematical and statistical foundations, capable of extracting relationships and/or new structures and/or new knowledge from the data, without explicit knowledge about the scope.
Deep Learning	Sequential, iterative, or hierarchical combination of different layers of non-linear processing (usually neural networks), so that the output of one level is incorporated into the input of the next level.
Reinforcement Learning	Reinforcement learning techniques establish an abstract and very simple framework to formalize the problem, in which an agent learns through interaction with their environment to achieve an objective.
Natural Language Processing	Very wide field of techniques seeking to analyse, understand, and obtain the meaning of natural language.

The generic objectives that the working group of this strategic initiative has identified are the following:

- Support the transformation towards **new health paradigms**. Knowing patients better should allow for more effective communications, involving stakeholders in shared health responsibilities, and facilitating transformation towards patient-centered systems.

- Improve **public health systems** Models should be developed that help professionals in the field understand the structure of epidemiological outbreaks, behaviors at population level, and the stratification system of population risks to improve predictive models of public health and the provision of activities and necessary resources.

- Improve **clinical information**. To achieve this, it is necessary to increase the quality of processing for existing information and the integration of different sources, as well as the quality of the information itself through controls at the point of entry, intelligent coding assistance, and new man-machine interfaces.

- Provide **assistance to health professionals and support tools for decision making**. AI tools must act as tools to assist in different aspects of clinical activity – such as differential diagnosis – and offer recommendations on treatment options. Likewise, they must extract key information from all patient information in the system according to specific domain scenarios. They must also structure the information and manage the creation of intelligent alerts based on segmentation processes and the establishment of pathological and treatment patterns.

- Improve the **efficiency and sustainability of the system in resource management**. This objective can be achieved through, for

example, systems that predict the use of certain services during specific time periods or absenteeism in outpatient care centers to optimally manage the care activity.

- **Empower citizens**. Intelligent cognitive systems, especially virtual assistants, can interact with users through natural language and learn from these interactions to adapt to these users' needs and personalize their messages.

Under the umbrella of the AI concept we can find various technologies with rather different degrees of maturity, availability, capacity, and applicability. In this particular case, the situation of constant innovation lends itself to a **pilot development** approach prior to the deployment of services throughout the system. As with other innovation initiatives, it is necessary to standardize and rationalize the pilots, evaluate them, and assess their scope in order to avoid, insofar as possible, the atomization and dispersion of practical applications.

Despite this situation, current AI techniques, which are combined with other technologies and integrated with adequate data repositories, are present in **tools for professional and personal use** in different fields. Incorporating AI solutions integrated into the central data repository will expand the opportunities to deliver value to professionals and managers for the improvement of care in quantity, quality, and accessibility.

"The information we already have is like a buried treasure chest. We have to dig up the chest and discover what's inside."

Hospital practitioner.

AI use cases

Public health	Predictive models of disease risk
	Patient segmentation and stratification
	Outbreak detection through text analysis enriched with social network observation.
Assistance aid and support for decision making	Assistance for decision making
	Diagnostic imaging: - Early diagnosis based on detection of stored image anomalies - Qualitative review of classification of medical images
	Mining of medical reports: - Unstructured information analysis - Classification of medical reports - Analysis of clinical notes - Extraction of relevant information
	Personalization of the information communicated to the patient
Health economy	Predictive models of resource use
	Resource utilization management
Citizen empowerment	Virtual assistants
	Patient segmentation to select the best communication channel

6.4. The Internet of Things

"The collection of data from sensors and personal or industrial devices is a new source of information for the EHR."

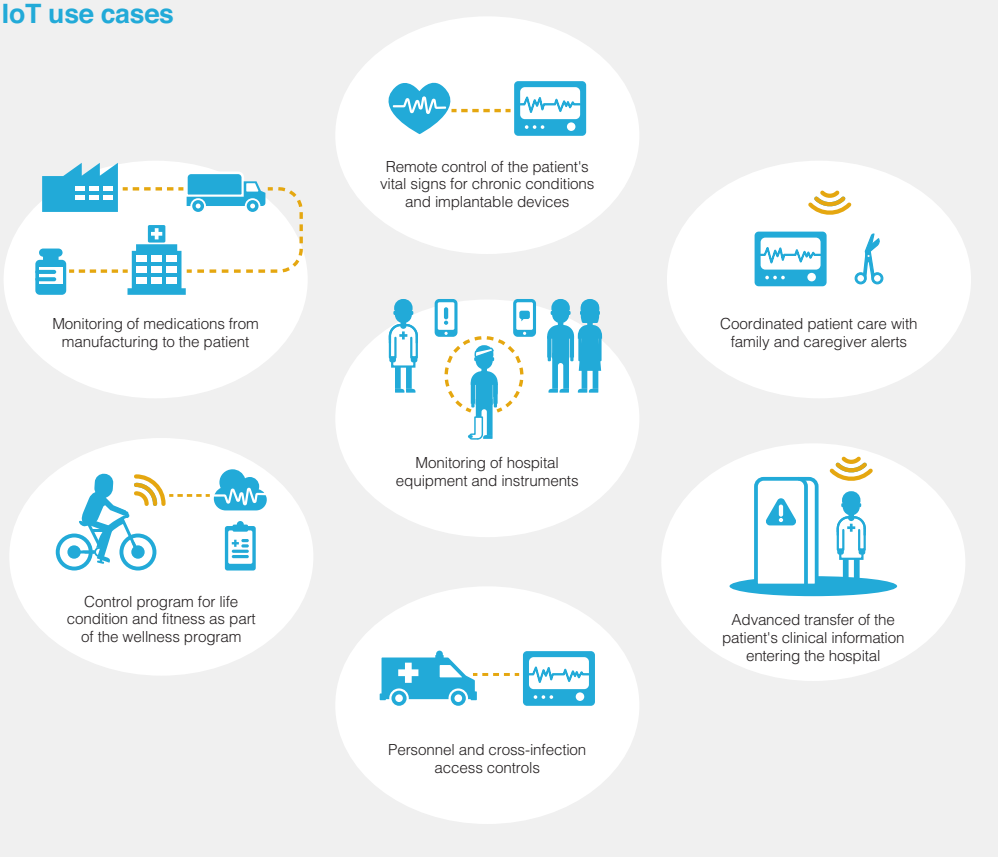
Working team.

The concept of the *Internet of Things* (IoT) is based on the ability of **connected elements** (from medical technology or general hospital facilities to household appliances or patient devices) to capture health information continuously, analyze it, interpret it, and transform it into concrete actions that can be executed by humans (both patients and professionals) or, in certain cases, the devices themselves.

The technological model of the Master Plan proposes IoT to be a **new source of data** with great future growth. This large amount of heterogeneous data must be part of the EHR repository and can be processed within the Data Lake of **Big Data**, which we referred to in a previous section.

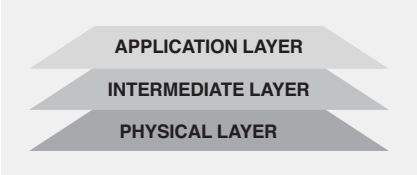
There are numerous IoT applications in the healthcare field. Use cases range from scenarios where data on assets and infrastructure are collected within hospitals or mobile elements (ambulances, hospital beds, people) to scenarios where the data collected is from patients (sensors in hospitals, at home, while moving about, etc.). Depending on the type of data collected, there will be different technological, security, ethical, and legal implications.

IoT use cases



To approach the **technological architecture of IoT** we can conventionally consider a structure of three superimposed layers like the ones shown in the figure.

Three-layer IoT model



- **Physical layer.** This includes physical devices such as sensors and actuators and the network connections necessary for the exchange of data between these devices. It also incorporates the network equipment required for communication between different systems (routers, antennas, etc.).
- **Intermediate layer.** This contains all the intermediate elements that allow managing the entry of big data generated by IoT technology which are necessary to analyze, process, select, and send the most relevant information to the application layer, according to the implemented service.
- **Application layer.** This uses the information processed for the provision of the service that has been defined, depending on the IoT technology deployed and the case of use. This layer also includes mechanisms for interaction with end users, business rules, and other services related to knowledge generation.

Although this architecture can already be found in existing medical devices in healthcare settings, today a whole new universe of increasingly evolving intelligent devices is on the rise. These devices offer different features and can capture data of all kinds.

On the one hand, there are devices used in the **personal sphere** (known as wearables), and on the other, a whole spectrum of **intelligent devices and industrial machinery** capable of collecting data in different environments, both institutional and consumer, and which are present in spaces that we use in our everyday life (home, city, transportation, work, etc.).

This **broadening of the scope of the IoT** from medical devices to elements that will be integrated into Telehealth models is a complex undertaking that requires very careful management if it is to be implemented. Given this new landscape of data access, health information, and services in "uncontrolled" environments, the healthcare sector must define the **mechanisms to evaluate and incorporate** these new sources of data generated outside its systems. In addition, this process must ensure the integrity and reliability of the data, while respecting **personal data privacy and protection rights**.

Conditions for the deployment of IoT solutions in Integrated Public Healthcare System of Catalonia (SISCAT)

- Security and privacy
- User authentication
- Interoperability and standards
- Management model and data structure
- Systems integration

The Master Plan is committed to the application of Telehealth and Mobility technologies, Artificial Intelligence, the Internet of Things, and the advanced use of data (big data) in a coordinated manner and in a comprehensive conceptual and technological framework.

These innovative initiatives should allow for big data readiness and analysis, as well as feedback to the different stakeholders in order to improve work processes, decision making, and the quality of healthcare.

We must establish a governance of innovation initiatives that covers the entire cycle of invention, experimentation, assessment, and extension throughout the healthcare system as a whole.

7

Governance

7. Governance

In this chapter, we will show the implications of the proposed information and technology model for the information systems governance of Integrated Public Healthcare System of Catalonia. First, we will present the needs that emerge when evolving from a diversified model of information systems into a coordinated one, as well as the opportunities that arise with the gradual expansion of the levels of standardisation and integration.

When we talk about governance, we refer to the **distribution of decision rights** within an organization or system that comprises different organizations. These decisions may be strategic (related to the allocation of resources and the portfolio of resources and services) or more operational (standardization processes, project management, or the provision of computer services).

Governance must be faithful to the chosen organizational and technological model. That is to say, the governance of the projects and services provided by a common or central body is different from the one of those managed autonomously through various levels of standardisation.

As indicated in previous chapters, the Plan proposes a ***coordinated* technological model**. This means that the different agents in the system share data and a generic model for workflow management between health care levels, but not the tools to support operational processes (with the exception of the Clinical Workstation for Primary Care, where most care providers use the same work environment).

In this context, a ***participatory* governance model** is considered the most appropriate option. According to this model, the stakeholders of the system recognise the right of the central agency to define policies and standards but keep their freedom to make decisions within the constraints of these rules.

7.1. A coordinated model of information systems

"Care providers share a lot of data in a coordinated model, but they are independent in their processes and organisation."

Working team.

Nowadays, healthcare centers are managed autonomously, within the framework of a relationship of trust with the Ministry of Health and the Catalan Health Service, which is carried out through:

- The **Health Plan**, as a strategic framework for the policies and actions defined over a period.
- The **accreditation** model, which establishes the conditions that provider centers must meet in order to be part of the network.
- The **program contract**, which determines the relationship of service provision and its economical compensation.
- The **data**, **process**, and **technology model**, which facilitates the relationship between the parties.

The governance of some provider entities is mostly owned by the Ministry of Health and the Catalan Health Service through consortia and foundations.

However, in terms of information systems, the model has so far functioned as a *diversified* model with a low level of integration, based on interoperability systems and the provision of some infrastructure and services through the Telecommunications and IT Centre of the Government of Catalonia (CTTI). One could say that there has been a **misalignment between the operating model and the technological model**.

Indeed, in the case of Integrated Public Healthcare System of Catalonia (SISCAT), a large number of customers and care providers need to **share large amounts of data** in the interest of healthcare quality, efficiency, and equity across the entire system (standardisation). However, they do so with a significant degree of **management autonomy**, given by the characteristics and variety of the healthcare providers, by their internal organizational models, and by the nature of the professionals' own practice (integration).

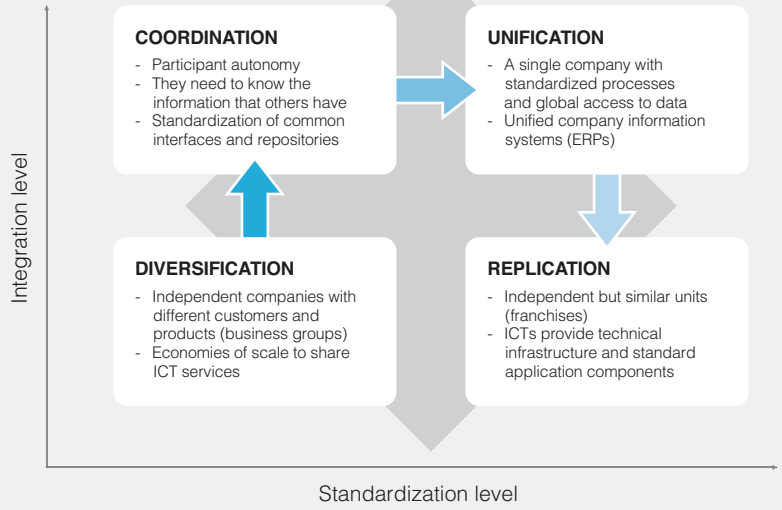
Due to the transformation of assistancemodels and the contractual conditions themselves, the healthcare model is evolving towards a greater integration. Therefore, the enterprise architecture must also be prepared for this process. It could be said that the healthcare model is a **coordinated** data model that, in some cases, can evolve towards a more standardised or unified model of processes, as it already occurs in primary care.

What is a coordinated model?

In the field of information systems, different categorisations of what is called "enterprise architecture" are established, that is, the high-level model of data, processes, and technology. Enterprise architecture must be aligned with the operating model and the organisational model That is to say, the way products are manufactured or services are delivered. Enterprise architecture also represents the foundations for the execution of the Plan, that is, the capacities to attain the overall mission of organising and transforming.

The two areas that usually determine enterprise architecture are, on one hand, its level of **integration** (sharing of products and customers) and its level of **standardisation** (conditions for the execution of management processes along the value chain). There are multiple possible combinations between the two areas.

Operational models



Coordinated models share data, as well as semantic and technical standards, in order to facilitate their integration. However, they do not share a unified model of processes. Therefore, they share neither +operational management systems nor common work environments.

More standardised (unified or replicated) models have enormous advantages of efficiency and predictability, and facilitate comparison and reduced variability. However, they often limit innovation and the costs of the transition can be very high, specially political and change management costs.

Note: The original model, which is deemed authoritative, was created by MIT professors Ross, Weill, and Robertson (2006). The model has since been discussed and updated.

"We must be able to offer solutions to healthcare centres with obsolete solutions, absent care providers, and with no money to apply the change."

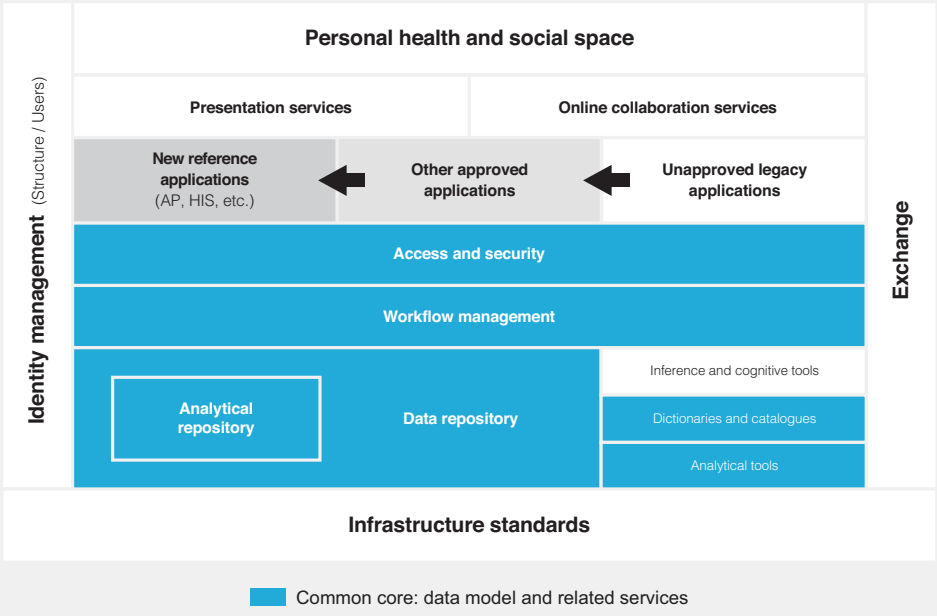
Hospital IT director.

The architecture proposed in the previous chapters responds to the characteristics of a **coordinated** model, that is, a **single data model**, with strong both technical and semantic standardisation, and in real or near real time). The model simultaneously offers a set of **'reference' services and applications** for service-providing centers that opt for a greater level of integration across Catalonia, and wish to migrate their transactional information systems (management applications and work environments). In these cases, the model could evolve into a more *unified* model, as it is already happening in most Primary Care Centers.

Finally, the model must allow sharing and generalising innovation, which is based on **collaboration** between the regulators, service-providing entities, professionals, and, of course, industry.

Without underestimating the effort, the complexity, and the cost (technical, economic, and organisational) of this transformation, it is important to become aware of the following: the construction of a single data repository and the reduction in the number of management applications throughout Catalonia facilitate governance and change management through integrated consortia or formulas of cooperation by different care providers in the same area). This alternative is less intrusive and encourages dialogue between stakeholders and convergence towards common solutions. This design solution -based on the exchange of structured data through a real time or near real time information exchange platform- will replace the voluntary creation and uploading of text documents (pdf) on which the current shared health record of Catalonia (HC3) is based.

Proposed technological architecture



7.2. Participatory governance

The analysis of international experiences reveals the configuration of structural, stable, and managerial governance that leads the transformation process as one of the key success factors. It is necessary to point out that the Catalan healthcare system is the only one among the Spanish autonomous communities in which such governance is not recognized (*Índice* SEIS [Spanish association of health IT index], 2016).

Considering the model chosen and the context, this configuration must combine, to be effective, management, leadership, and regulatory authority components on the one hand, with components of participation and assistance among managers and technicians of the Catalan healthcare system on the other. We could call this a ***participatory* model of governance**.

Considered in this way, it is also easier to determine a specific **financing framework** that assists in broadening the model and its consequences to the framework for **contracting care services**. To be successful, the financing of technology investments should have an **end view** with incentives that favour technological renovation its alignment with the proposed information model, as well as being **appropriate** for achieving the Plan's goals and **sustained** over time.

Therefore, and conversely, the care services contract should exclude, sooner rather than later, the variable part associated with the fulfilment of information requirements, as well as the transfer of records and data other than those from the eHealth Record.

Financing of the Plan

The revision of international experiences and scientific literature reveals some interesting conclusions about the value of transformation processes in information systems. Generally speaking, investing in information technology increases productivity and the quality of the offered services. Nevertheless, this is not always the case:

- The organizations that benefit the most are information-intensive companies such as healthcare.
- Remarkably, the greatest barrier when obtaining the benefits from health data management has been the lower investment in information technology and the lack of analytical talent.
- To be effective, investment should not be a one-time action, but a stable and sustained commitment over time.

"Sponsorship for the health service buyer must be real. This has consequences on the contracting model of services . It also affects the type, and even the 'tone' of the relationship between the service-providing entities and the planner. The project cannot be seen as an intrusion but as an opportunity to increase transparency through comparison and feedback between entities and professionals to improve care provision."

Manager of an integral service provider.

"One of the key factors in any process that requires interaction with technology is that the end users find this technology useful and usable. The same thing occurs with EHR systems. Therefore, it is important that clinical and non-clinical staff interacting with it are very convinced of the solution's design and its functionalities. In this regard, when designing the solution, the most usual approach is to involve all the types of stakeholders that will end up being users."

Conclusion drawn from the analysis document on international experiences of information systems transformation in the health sector, June 2017

The case of Denmark

Denmark and New Zealand are probably the most advanced examples of transformation of information systems. In both cases, the organizational model of provision is similar to the one in Catalonia and the longitudinal Electronic Health Record (EHR) is the backbone of the Plan.

When comparing their approaches, however, some differences stand out when analysing the governance of the projects and services they should have implemented. In this regard, the Danish Government was more successful: because they created a set of individual and member-based bodies of governance and management:

- The **Danish National Board of Health**, under the Ministry of Health, is entitled to develop specific requirements on the use of ICTs in the Danish health system: the development of a catalogue of functional and technical standards, the creation of common infrastructures, giving real-time access to information, and the consolidation of national records.
- The **Regional eHealth Organization** is an interest group consisting of Denmark's five regions, which seeks to accelerate and coordinate the implementation of eHealth. This includes, for example, reaching agreements with the Government to finance the program.
- **Local Government Denmark** is the association of municipalities in Denmark. The municipalities provide most health services at the local level and form a coalition of stakeholders for the implementation and extension of eHealth.
- **MedCom** is an agency created jointly by the state government, regions, and local communities. This agency works towards the development of national projects that involve support between primary care, public and private hospitals, the municipal sector, and laboratories and pharmacies, including telemedicine. It is also responsible for managing the Danish Health Data Network, generating connectivity standards and acting as a systems certification authority so that they can connect to its network.

Finally some other aspects stand out when analysing the international examples and the successful local experiences in Catalonia. These are the managerial **commitment** and **conviction**, and the clinical **leadership** and **involvement** both in the design process and the implementation of solutions. In this context, it is considered a success when the community adopts and effectively uses tools that not only support their working methods but also allow their transformation into new models of healthcare.

7.3. Design criteria

The governance of the information systems proposed for Integrated Public Healthcare System of Catalonia (SISCAT) is based on the **principles** and **values** that the different system's stakeholders want to share, regarding the information systems and technologies, the way we understand information services, and the relationship between us regardless of local technology solutions.

Principles and values regarding ICT management

- **Strategic ICT planning aligned with the health and services strategy**
  - Five-year Master Plan (eHealth Strategy), reviewable biannually, according to the Health Plan guidelines.
  - Focus on a small number of strategic initiatives, separate from demand management and ordinary operation.
  - Purpose-driven resources assigned to the Plan during the five-year period.
- **Service oriented technology architecture**
  - Maximum standardization, modularity, flexibility, reduction of the customisation effort, and maintenance and ease of cloud migration.
  - Data centric: data as the strategic asset of the Integrated Public Healthcare System of Catalonia (SISCAT). Management and global governance of data, avoiding information silos.
- **User-centred and community service applications**
  - User-centred design (UCD).
  - "Bimodal" portfolio management, encouraging the use of "agile" methodologies.
  - Construction preferably based on open source software and the creation of a developer community.
  - Selection of tools based on standards with open programming interfaces.
- **Robustness and operational safety**
  - Scalable, redundant, and highly available services for the Electronic Health Record and the technological infrastructure that supports it.
  - Strict definition and monitoring of the standards of availability and response time for each service, according to its criticality.
  - Risk-free evolution toward an Infrastructure as a Service (IaaS) model.
- **Data security and privacy**
  - Data protection policy aligned with APDCAT and reviewed annually (compliance with LOPD regulations (Data Protection Act) and data subjectrights).
  - Common security and privacy policies for all of Integrated Public Healthcare System of Catalonia (SISCAT) Security Board with participation of the Telecommunications and IT Centre of the Government of Catalonia (CTTI) and healthcare providers.
  - Private cloud policy.
  - Training for professionals in security, privacy, and zero error policy.

"Doctors and nurses have been more willing to collaborate on common projects than IT professionals themselves. The Master Plan is an opportunity to change this dynamic."

Hospital IT director.

The governance model is ambitiously designed to place the Catalan healthcare system on the same level of the most advanced organizations in data and technology management. These organisations recognise the **strategic role of information systems** in supporting and transforming their work processes, and **rely on data to make decisions** at any institutional level. Specially, when the operators are highly qualified professionals.

Normally, this recognition is associated with **a corporate ICT governance**, a top-level managerial position of its managers, and an adequate provision of technical and human resources.

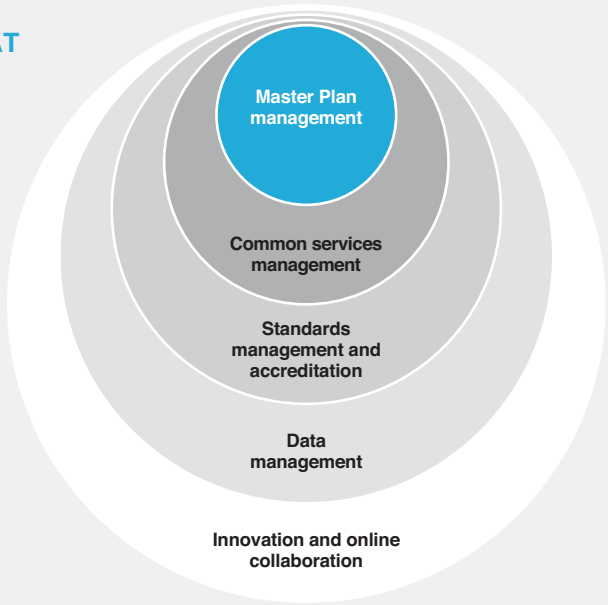
Areas of governance

- **Portfolio and investment management**
  - Investment prioritisation and justification
  - Asset portfolio management
  - Enterprise architecture
  - Strategic planning
- **Organisation**
  - Systems and technologies distribution
  - Provisioning and outsourcing
  - Decision power distribution
  - Corporate governance
  - IT services organisation
- **Data management**
  - Data architecture
  - Life cycle management
  - Standardisation and approval
  - Integrity and quality
  - Security and privacy
- **IT services management**
  - Technical infrastructure: network services and workstation
  - Project and application management
  - Customer service

It should be noted that, in many of these areas, the health system (both at the corporate level and at the level of some medium and small healthcare providers) has not been able to develop capacities, methodologies, and resources that are relatively common in other private economic sectors or even in other areas of the public sector.

The Master Plan does not seek to determine neither the organisational structure nor the legal or organic form that this function should have. However, the Plan should determine the main areas and management processes that need to be addressed, and which is the most appropriate approach for its deployment.

Conceptual design of the governance of SISCAT information systems



The first and main role of the corporate governance structure is the management of the transformation itself – that is, the **execution of the Information Systems Master Plan** –, and the construction of both the architecture and the main strategic initiatives in the form of projects. The plan also comprises the **creation of an Office** for the program and a **monitoring body** with the participation of the service-providing entities.

Because of the Plan, **new products** and **services** will be delivered to the sector, mostly as applications. These will have to be implemented, maintained, and updated through the Plan's structure, through the public tender for specialized care providers, and through a specific relationship with the Telecommunications and IT Centre of the Government of Catalonia (CTTI). This relationship should be specific to the health sector, and consider the fact that most of the operators are not part of the organic sphere of the Government of Catalonia.

A relevant part of its work will not be the delivery and maintenance of its own projects and services, but the coordination of services that it will not manage directly. In these cases, it will be up to corporate governance to establish processes of data **standardisation** and the **approval** of solutions through the establishment of a **technical advisory board** with the participation of care providers.

"Standards cannot be established while ignoring the community. The Standards Bureau must work with technical autonomy and use internationally accepted standards as a reference."

Working team.

The Standards Bureau

The 2016-2020 **Health Plan** already pointed out, in some of the projects in the field of digital health, the need to establish a board of experts in information management and modelling, data flow, and the homogenisation of catalogues, ontologies, and archetypes. The foundation *TicSalut* Social created the Catalogues Office in order to provide itself with experts for the definition and homogenisation of catalogues.

The Standards Working Group has confirmed the need to coordinate these actions with those planned in the Master Plan:

- **Awareness of the needs** that may be generated by the implementation of common standards throughout the health system, since they may differ depending on the centre. Hence, it should be analysed whether this entity can give enough support to the centres for them to assume the models of standards adoption that may be established.
- **Promotion of the communication policy** between the Administration and the care centres, as well as in the Catalan health system, so that it is more fluid and allows collaboration and help between the different elements that form it. This way, the use of standards would be spread across all centres that constitute the healthcare network, regardless of their possibilities and resources.
- **Relationship with the industry.** The entity responsible for interoperability in the Sistema Sanitari Integral d'Utilització Pública de Catalunya (SISCAT) [Integrated Public Healthcare System of Catalonia] must provide the industry with the standards that aims to adopt, as well as request answers from the industry based on the proposed needs and requirements.
- **Approval and certification.** The office of Interoperability Standards and Catalogues (OCEI) must be in charge of interoperability within SISCAT. It must define the standards and adoption models for these standards in the centres and conduct their homologation and subsequent certification.
- **Provide support to the centres** to facilitate the adoption of standards throughout the health system.
- **Autonomy.** Regardless of the political changes that may occur, this entity must have sufficient autonomy to maintain quality, standards, and its performance in the health system.

The adoption of standards in the Catalan healthcare system will be based on **internationally recognized standards** – as long as they exist.

If the core of the Master Plan lies in the use, analysis, and **management of data**, professional and specific governance of this area is necessary, along with a vast training program and the development of digital and analytical talent for all the professionals of Integrated Public Healthcare System of Catalonia (SISCAT).

"We computer scientists have to broaden our point of view. We must go from being technology providers to being data providers."

Hospital IT manager.

Data management

Data management is a relatively new function in the world of companies and organisations, which began to rely on it by the end of the twentieth century. It can be defined as "the development, execution, and supervision of plans, policies, programs, and practices to control, protect, deliver, and increase the value of data and information assets" (Data Management Body of Knowledge).

- **Data architecture** management: the structures, dictionaries, semantic rules and technical standards, and their relationship with the enterprise architecture and the technological architecture.
- **Data development**: the modelling of data and the construction of databases.
- **Data lifecycle** management processes: registration, storage, retrieval, exploitation, and analysis.
- **Security management** in a broad sense: security policy and standards, classification, administration, authentication, and data auditing.
- **Data management**: the information, definitions, calculation formulas and data location inside a system.
- **Data warehouse management**, whether they are conventional structured data warehouses (Data Marts and Data Warehouse) or the new unstructured data repositories.
- **Quality** management and data **integrity**.

In complex organizations, the data management function may be separated into different functional or technical units. Hence, the corporate data management function has an orchestration role for common policies, processes, and practices.

Finally, to incentivise and generalise innovation, it will be necessary to create **communities of professionals working** in networks, incentives for collaboration, and a process of evaluation and extension of local solutions. The relationship with universities and industry will be a key factor.

Key features of the governance model

- A *coordinated* technological architecture: data standardisation, autonomy of the processes.
- A *participatory* model of governance: managerial and regulatory leadership, and advice and participation by the service-providing entities.
- A variable *geometry* model: different decision rights according to the type of project and technological service.
- Clinical leadership and involvement, from the design to the implementation process.
- End-view financing: incentivised by and aligned with the adoption of the new technological model.
- New relationship model with the Telecommunications and IT Centre of the Government of Catalonia (CTTI)specific to the context of the Integrated Public Healthcare System of Catalonia (SISCAT).
- Replacement of the variable part of the service contract, and of the transfer of separate records in the Electronic Health Record.
- Massive digital and analytical talent development program.

To conclude this chapter, it can be said that the Master Plan contemplates a system of **participatory governance** of information systems, aligned with an information model in which independent entities need to share data for the benefit of patients, the professional practice, and the effectiveness of the system. This model requires the establishment of a **managerial role** and different **participatory and advisory bodies**.

It is proposed to deploy **a service and an advanced professional structure** of information and technology management. This service must be responsible for implementing the Master Plan, for the projects and services that are common, for the governance of the data, and for the establishment of standards and accreditation criteria.

Having a **specific financing framework** – which is **also sufficient, stable and sustained** over time –, as well as a specific relationship model with the Telecommunications and IT Centre of the Government of Catalonia (CTTI), are critical success factors for the implementation of the Plan.

8

Transformation plan

8. Transformation plan

In the previous chapters, we have presented the justification and benefits of the Plan and its main components. We wanted to show the Information Systems Master Plan as an instrument of the **Health Plan** that goes beyond the construction or replacement of technological elements. The Plan aims to make a leap forward in the **use**, **analysis**, and **management of data** to improve access to healthcare, its quality, efficiency, and equity for all citizens. The Plan puts people (citizens and health professionals) at the centre of the information model.

The core idea of the Plan is the creation of the longitudinal **Electronic Health Record** (EHR) as a **common language** and a **technical repository** that allows sharing and having access to patient data at any point in the care chain, as well as facilitating interactions between patients and professionals within the healthcare system.

At the same time, it envisages that the evolution of the EHR can be a longer-range **information model** over time, incorporating new healthcare work environments (starting with the new Clinical Workstation for Primary Care) and other value-added services. It also anticipates an active strategy to incorporate technological innovation throughout the Integrated Public Healthcare System of Catalonia (SISCAT).

The Plan is complex, necessary for adapting to a complex organization such as the Catalan healthcare model and the ICT management itself, both within the scope of the Government of Catalonia and of the wide variety of entities providing medical and non-medical services. The management of this **complexity** will be a requisite for achieving the purposes we have set.

In any case, success does not lie in the quality of the diagnosis of the starting point or of the design of the technical model but in its implementation. The Plan will succeed if it assists the organizations, and the healthcare system as a whole, in putting it into practice.

This chapter proposes an **agenda**, or an execution approach for the Master Plan, its most important components, and the relationship between them.

8.1. Critical success factors

Throughout the project, and especially during the last part of its deployment, we weighed these success factors or requisites together with a myriad of managers, professionals and system technicians. They hardly mentioned technical conditions. Instead, on many occasions, they pointed out **cultural** and **organisational factors**. The history and culture of a segment of the healthcare system are still unyielding to the idea that data does not belong neither to the organization nor to the professional, but to the citizen, and that only if data is shared can it become a value for improving their health and the healthcare system as a whole.

Fragmentation of technological solutions, communication based on document viewing, and delivery of records could be necessary justifications for the transformation of the information management model. However, they are not the most important nor sufficient. It is important to highlight the **benefits that the change will bring for citizens and professionals**: to ensure medical attention and integrated and continued monitoring of patients, facilitating relationships within the system, and the collaboration between different professionals and medical services. In this context, it should be noted that they will only share relevant and common clinical information, occasionally (only when it is needed), and of high quality, easy to record, to access, and to analyse. Effective communication of these core ideas, pedagogy, and change management will be key.

For health organizations and healthcare provider entities, the fact that common and relevant data on the registration of activity

and on the complexity of healthcare are progressively deposited in a shared space will allow reducing coordination costs dramatically. It will also help decrease a relevant part of the costs of computer services dedicated to software updating in order to respond to the requirements of planners and evaluators. It should also be possible to simplify contractual models and improve relationships based on trust and collaboration. The corporate bodies of Catalan Health Service and the Ministry of Health must exemplify these benefits to gain additional credibility in the healthcare sector.

In this sense, both the sensitivity of the participants in the project and the analysis of international experiences show that, in these technological transformation processes, it is essential to introduce the **strategic value** of data management into the agenda of politicians and managers. The investment in technology and the development of **governance and financing mechanisms** should facilitate the process of change management and the establishment of opportunities and incentives that give visibility and credibility to the Plan.

Catalonia is the only autonomous community in Spain, with executive and regulatory capacity, that does not have an **organic structure for the directive role of Healthcare ICT governance**. As we mentioned in the chapter on Governance, reversing this situation is urgent and it is a condition for the deployment of the Plan. "Data and information technology governance" also means recruiting, equipping, and **developing professional talent, as well as evaluating the provisioning and management models** of computer resources in order to adapt them to the specificities of the healthcare sector and an Information Systems Master Plan of such an extent. These are currently under the administration of both the Telecommunications and IT Centre of the Government of Catalonia (CTTI) and a wide range of external care providers.

At the same time, the singularity of the Catalan healthcare system, based on the diversification and autonomy of healthcare providers management, requires a model of **participatory governance** in which the service-providing entities contribute to the monitoring of the Plan's execution, and advise on the establishment of both functional and technical **standards**, both fundamental elements in the proposed model.

Regarding resource provision and allocation, a specific and **end-view financing framework** is required (one that is separate from the ordinary contract for financing healthcare services) with incentives that favour the renovation of the technology park and its alignment with the proposed information model. This framework must be **adequate** for achieving the Plan's objectives and sustained over time.

In order to benefit from the massive availability of clinical information and from the exploitation and analysis tools, it is necessary to have a highly technical core and solvent healthcare providers. At the same time, it is required to have a massive **digital and analytical talent development program, which** progressively aims at all the professionals and managers of the Integrated Public Healthcare System of Catalonia (SISCAT), and, which considers their roles and needs (reflected on the strategic initiative regarding analytical talent and digital training).

The review of the successful experiences that SISCAT has carried out both at the corporate level and among the service-providing entities in the field of information systems and international trends shows the importance of **leadership and the involvement of healthcare professionals**, from the conceptualization and design of the solutions to their implementation, maintenance, and improvement.

From the technological point of view, the different working groups that have developed the strategic initiatives in the final stage of the project have identified a series of success factors or conditions that overlap. These groups agree that **collaborative governance** is required. Such governance must be able, on one hand, to take advantage of the capacity of local talent and of the innovative initiatives that already exist within the providers, and, on the other hand, to facilitate collaboration between them.

"Now that there is much talk about 'storytelling,' a story that clearly shows the benefits of the project in terms of care, not technology, is needed. In this story, the important thing is not asking 'why' but 'to what end', that is, what we will be able to do that is new or different from what we do now."

Hospital Manager.

"Implementation is the people. Choosing the right people, developing them, facilitating their commitment, and helping them make things happen."

Manager of an integrated service provider.

In respect of the information systems design, the new model must be conceived with and for the **users who employ them**, especially the design of the new workstations. Regarding the **development of applications**, there must be a combination of custom development and a call for tenders that preserves the technical and functional knowledge of the system, allows reusing knowledge and the integration of new applications through open interfaces, and ensures independence from manufacturers and implementers.

Finally, all the working groups, professionals, and managers who were consulted pointed out as one of their main concerns the policies, processes, and tools for **data protection and data privacy**, which with the eHealth record model are still local, but reach a new systemic dimension.

Critical success factors for the implementation of the Master Plan

- **Communication and change management:** Showing the benefits for citizens and professionals.
- **Lead by example:** Simplifying the relationship between corporate bodies and service-suppliers.
- **Framework for the funding of the Plan:** End-view, adequate, and sustained financing.
- **Executive and normative leadership** on information systems: Management role and provision of resources.
- **Participatory governance:** Involvement and guidance by the sector in the monitoring and execution of the Plan.
- **Collaborative governance:** Cooperation and sharing innovation between the technicians of the sector.
- **Systems design by and for users:** Leadership and involvement of professionals in the design, implementation, and improvement of information systems.
- **Development of analytical talent:** Recruitment and development of digital and analytical talent segmented by groups.
- **Priority for data security and data protection:** Local and systemic dimension.

8.2. Overview of the implementation plan

"The success of the Master Plan is not to make a master plan. What is required instead is a strategic approach sustained over time and that manages all aspects that derive from the strategy, from the justification of investments to the implementation and effective use of information, applications, and technology. (...) The failure to achieve the established strategy is often the result of improperly handling organizational, political, and cultural issues."

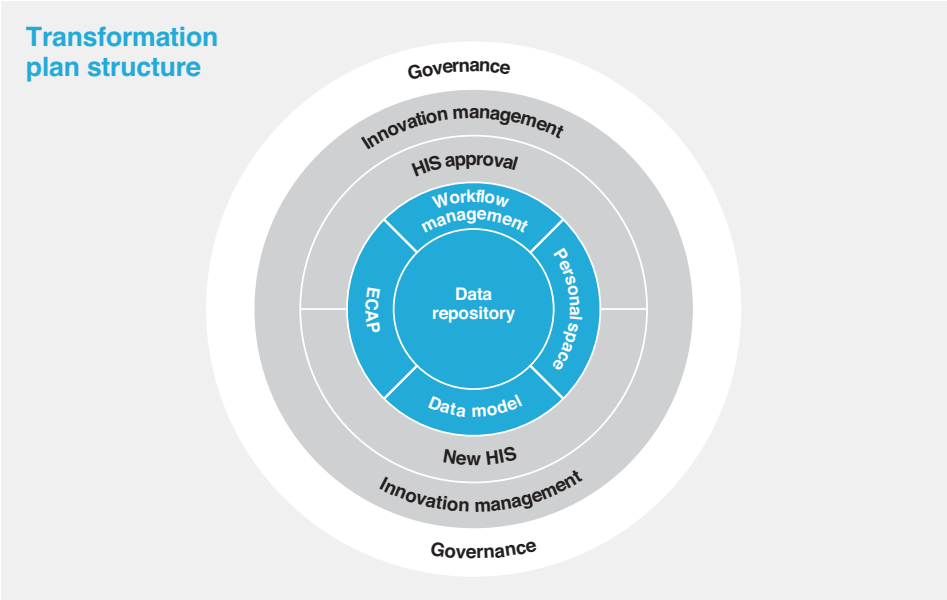
Member of the Master Plan's Project Office.

With the followed working method, the vision stage (completed in July 2017) allowed us to obtain the following: a structural design of the new information model based on the Electronic Health Record, the homologation and development of new reference work environments for primary care and specialized care; the incorporation of new technology for digital transformation; and the integration into the model of some specific areas that were not, initially, extensively analysed, such as social health, mental health, or pharmacy services. We call these workspaces **strategic initiatives** and, for each one of them, we created a working team, led by professionals of the healthcare system, both from the technology area of the service suppliers and care professionals. All of them,all under the operational coordination of the foundation TicSalut Social.

The objective of this stage, known as the **Deployment Plan**, was to confirm or modify the initial vision, determine the objectives, extent, and dimension of the effort, and establish a tentative roadmap for each strategic initiative.

Based on this analysis, the Strategic Committee of Chief Information Officers (CETIC) has established a structured implementation approach in **five areas** and twelve lines of work for the temporary period of the Plan, that is, between **2018 and 2022**.

Transformation plan structure



1. In the first block, **an initial data repository** is created. This repository is fed with the information that is already scattered across the system from different sources and that constitutes, in practice, most of the information that the data model will have. This information is left at disposal of Integrated Public Healthcare System of Catalonia and, at the same time, the elimination of reporting and information delivery systems begins. This first block includes the design of the training program in data analysis and the completion of the first courses.

2. The second block is much more complex. It aims to provide the EHR with structure and farsightednessthrough **the transformation of the Clinical Workstation for Primary Care** (ECAP). Its database will already be the common repository of the EHR, so this stage's goal is to work on its **data model**, from both a semantic and a technical point of view. Specialised care professionals will also have to participate in this design. The core of the EHR also includes the **workflow manager**, which is part of this area of activities. The result of this reengineering process also allows visualisation of the information and improvements in the interactions citizens have with the system through the new personal health space, which is an evolution of La Meva Salut [the citizen's personal health folder]. This area also includes an emergency plan to improve the workplace of healthcare professionals, whether these are fixed or, especially, mobile.

3. The third block includes the **actions on applications for specialised care management**. The plan is to, first, homologate the current clinical workstations (their structure, information exchange standards, and security) to ensure their compatibility with the EHR. At the same time, the process of design and construction (or acquisition) of a new reference tool – **a new Hospital Information System (HIS)** – is launched for care providers that require such use or want to make the change.

4. The fourth block consists of a process of **innovation** empowerment, sharing, and management throughout the system that is focused on tools that reinforce the defined information model (such as, Big Data, the Internet of Things, Artificial Intelligence, and Telehealth and Mobility).

5. The fifth block includes the policies, structures, and mechanisms of **governance and financing of the Plan**, which will be deployed as the Plan is implemented.

This structure is not sequential and does not imply a work schedule. In the **executive implementation program**, each area is made up of elements of variable range within a schedule that takes into account the evolution of projects that are already underway, short-term emergency plans, and improvement actions, as well as the elimination of other projects, services, channels, and mechanisms that do not add value.

"When talking about change management, we don't have to think about a collection of well-intentioned messages. Examples of success should be shown and, from here, we need to build on them and allow them to grow. It is important to succeed in the first projects that are launched."

Manager of an integral service provider.

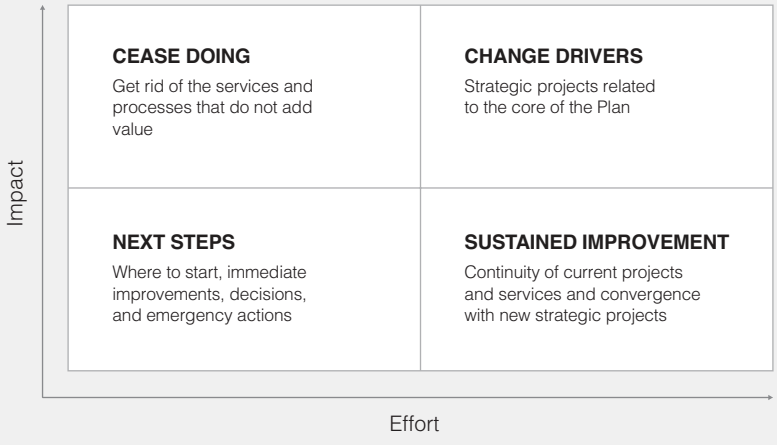
Implementation schedule

From the method's standpoint, a Master Plan is considered a work **program**, that is, a set of lines of action and projects of variable range, effort, and impact aimed at achieving an objective or a set of related objectives.

The most important thing about a program is having an **integrated and global vision of the Plan**, its component parts, and the relationship between them. In any case, it is even more important than a detailed planning, as it can only be done at the project level. Oftentimes, the technical aspects are not as relevant as the strategic and organizational aspects.

The portfolio of actions is organised according to the impact it has on the "business" and the level of effort required. It includes the relationship between the projects that are underway and new ones, as well as the initial steps for the implementation of the Transformation Plan. Therefore, the program includes different types of initiatives. The block "Cease doing" is especially significant. It consists of the projects and services that can or should be discontinued whenever new ones are developed.

The implementation schedule is, rather than a planning model, a "mental" model (a way of thinking and doing), which is very useful in any kind of strategic planning project.



The Plan envisages the **convergence** between projects that are already underway and the new EHR design. Therefore, the evolution of the Oficina eSalut [eHealth office] projects [the shared health record of Catalonia (HC3), the interoperability platform (IS3), the citizen's personal health folder (La Meva Salut), etc.] and the improvement and evolution of the ECAP project are coordinated.

According to the governance model described above, the Plan also takes a different approach depending on the type of project or service: projects that involve the construction of common or territorial services (such as the construction of the EHR); projects that provide standardisation services and the accreditation of local services; and the incorporation and management of innovation throughout the Integrated Public Healthcare System of Catalonia (SISCAT).

Next we will describe each one of these areas.

8.3. Construction of the data repository and creation of value-added data services

The objective of this initiative is to build an **intelligent repository of information** based on records that are currently scattered and that follow parallel circuits and means, but which in practice represent most of the information the system needs to share for healthcare or management purposes. These records include information from the the shared health record of Catalonia (HC3), the interoperability platform (IS3), the minimum hospitalization data set (CMBD), the data on waiting lists, and the RSA platform (*Registres Sanitaris Agregats* [aggregated health registries]).

Most of this information is already in a **structured format**, has been produced and shared for a long time, and has a reasonable level of quality. This is so because the professionals themselves take care of it, because data is subjected to different accredited processes of coding and clinical documentation, or because they are used for billing and are auditable.

The proper focus is to **label** and **cross** these data and subjecting them to **Data Cleansing** processes to ensure their integrity.

It could be said this is a very pragmatic approach in order to build, in the short term, a robust basis for a transactional and analytical repository, with the high-quality information that is already available, such as the one derived from the shared health record of Catalonia (HC3).

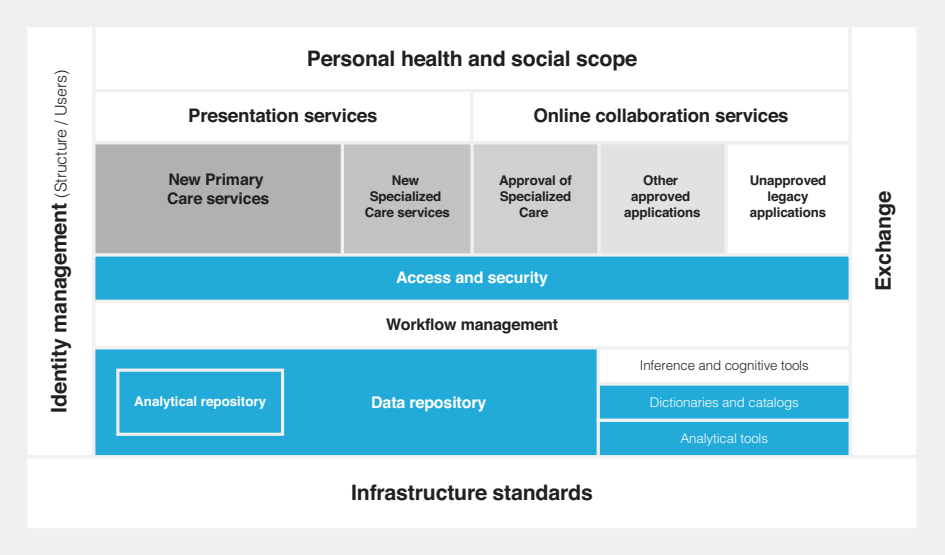
As the repository is built and becomes refined and accessible to users, the transfer of files that is currently done through different means and circuits will be replaced.

The project includes the short-term creation of **analytical services of added value**: a clinical terminology server, a service that offers **return to healthcare providers** so that they can quickly compare their performance with the rest of the system (and at no charge), and the agile **creation of reports, dashboards**, and **data mining** for the services of Catalan Health Service, which will be accessible to all service-providing entities.

"It is easier to start sorting and taking advantage of the information that Catalan Health Service already has, especially information from hospitals."

Hospital manager.

Construction of the data repository



Schematically, the technology platform that supports the data repository will offer the following services:

- Web presentation and API (application programming interface) management, with the implementation of a first level standard of presentation and API.
- Authentication services.
- Access management.
- Clinical terminology and dictionary server.
- Structured and unstructured databases for recording actions and transactional statements.
- Unstructured databases for external data storage.
- Data Warehouse and Data Lake management platforms (data integration, staging, and analysis).
- Base set of analysis tools.

The development of the different strategic lines will complete the content of the data model and refine the associated services. Likewise, the evolution of the HC3 platform must be oriented towards the use of the repository design to provide information and use of its services until it is fully integrated.

Finally, this area includes the design of the **training program** for the development of digital and analytical talent, aimed at different types of professionals within the *Sistema Sanitari Integral d'Utilització Pública de Catalunya* (SISCAT) [Integrated Public Healthcare System of Catalonia], and at teaching the first training programs.

8.4. Creation of the data and workflow model coordinated with the development of the new Clinical Workstation for Primary Care

Undoubtedly, this is the most complete and complex area of the program, which **allows modernising the Clinical Workstation for Primary Care** (ECAP) and simultaneously **configuring the functionalities and the technological model of the Electronic Health Record**. In addition, in this block, the value of the eHealth record should be highlighter for both the professionals and the citizens, through the creation of the new **personal health space**. The area is structured across five lines of work:

The new Clinical Workstation for Primary Care

As we mentioned earlier, the transformation of the Clinical Workstation for Primary Care is a great opportunity to define the data model and processes required by the Electronic Health Record and other services until the integrated information model is completed.

In fact, the EHR is based on the primary care, which is the gateway for citizens into the healthcare system and the main tool for monitoring patient interactions with the different healthcare services. From the very beginning, in this construction, the logics of the **health condition and problem** must be connected with the logics of the epicrises, inherent to the **hospital care episode**.

The main characteristics of the renovation of the ECAP from a functional and technological point of view were presented in chapter 5 and can be found more extensively in the conclusions of the working group for strategic initiative 6, which are published on the website of the Plan.

From a technical standpoint, the incorporation of services related to primary healthcare involves completing the **presentation services** to the end user and verifying the scalability (growth capacity) of the services related to the repository. Information from all levels of care is needed to provide healthcare professionals and primary healthcare managers with a complete information environment. Therefore, the information available in the shared health record of Catalonia (HC3) and the interoperability platform (IS3) relative to other levels of care will be integrated from the beginning.

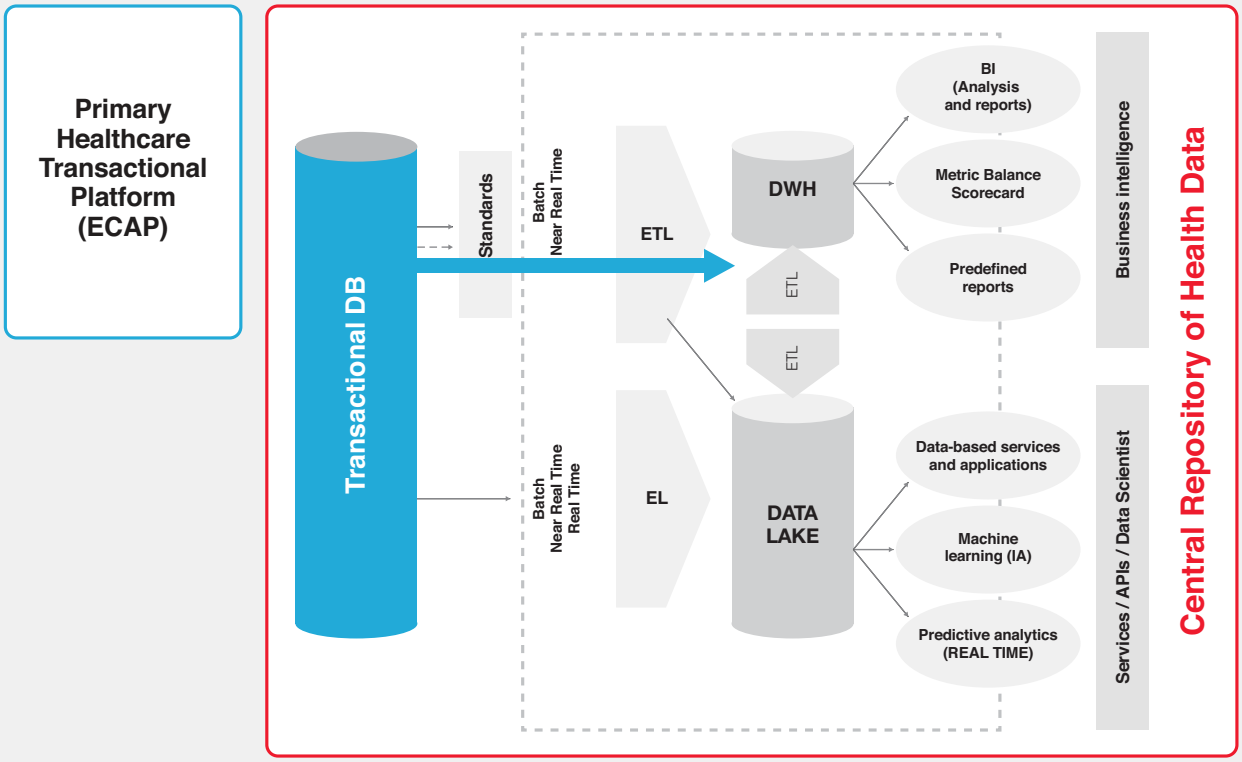
The process of creating a new work environment for primary care is very complex, as was pointed out before. For this reason, its deployment is expected in phases, combining the development of the work functionality of care professionals and the creation and unfolding of the central data repository.

In the **first phase**, the workstation database is transformed into the common transactional data repository of the entire system. Given the integration of the analytical repository of the data model, all transactional and analytical information from the primary healthcare setting will be accessible throughout Integrated Public Healthcare System of Catalonia (SISCAT).

"If it makes sense to start with the information we have in hospitals in order to launch the data repository, then it is better to design the future data model by focusing first on primary healthcare."

Hospital Manager.

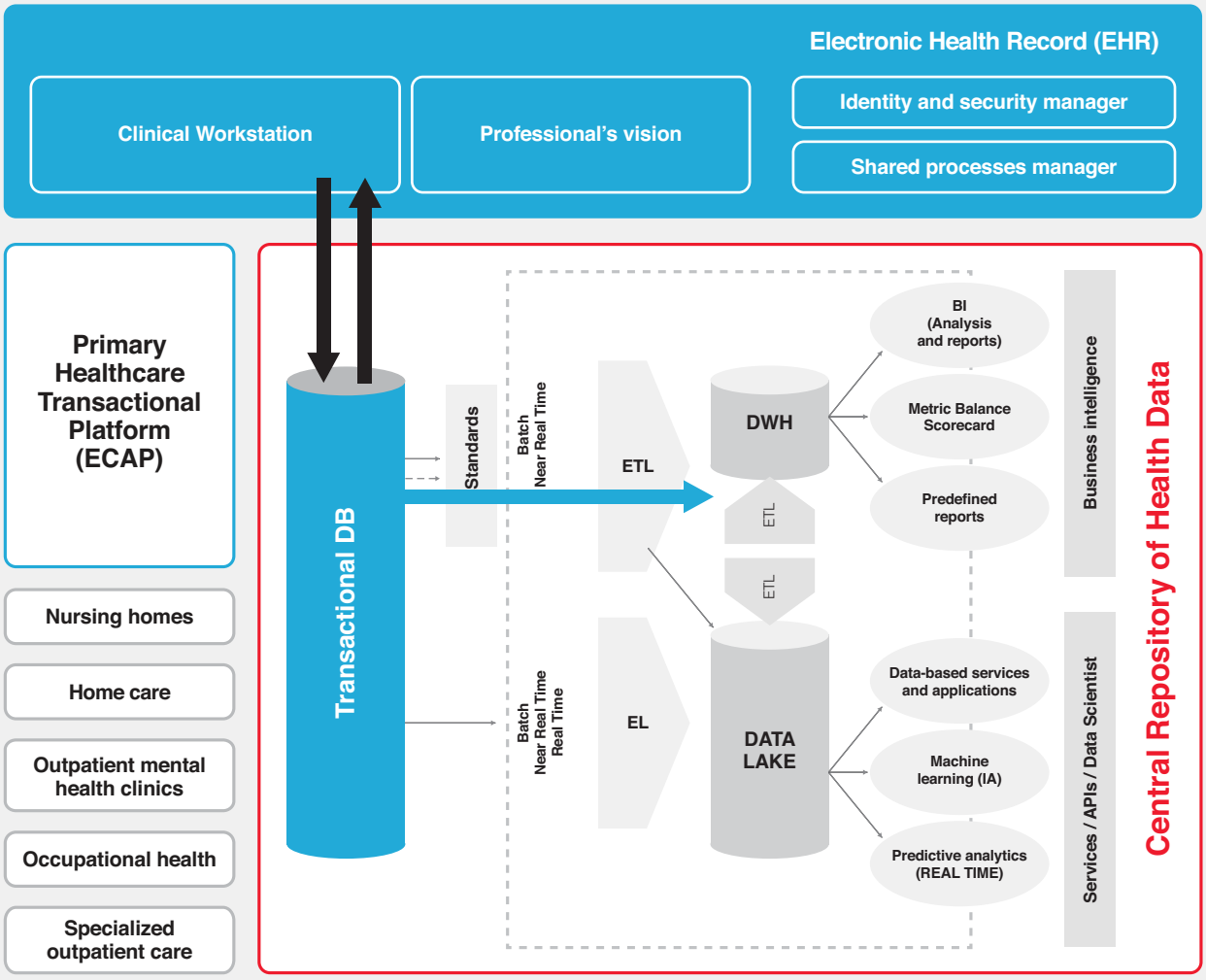
Linking of the system to the new data repository



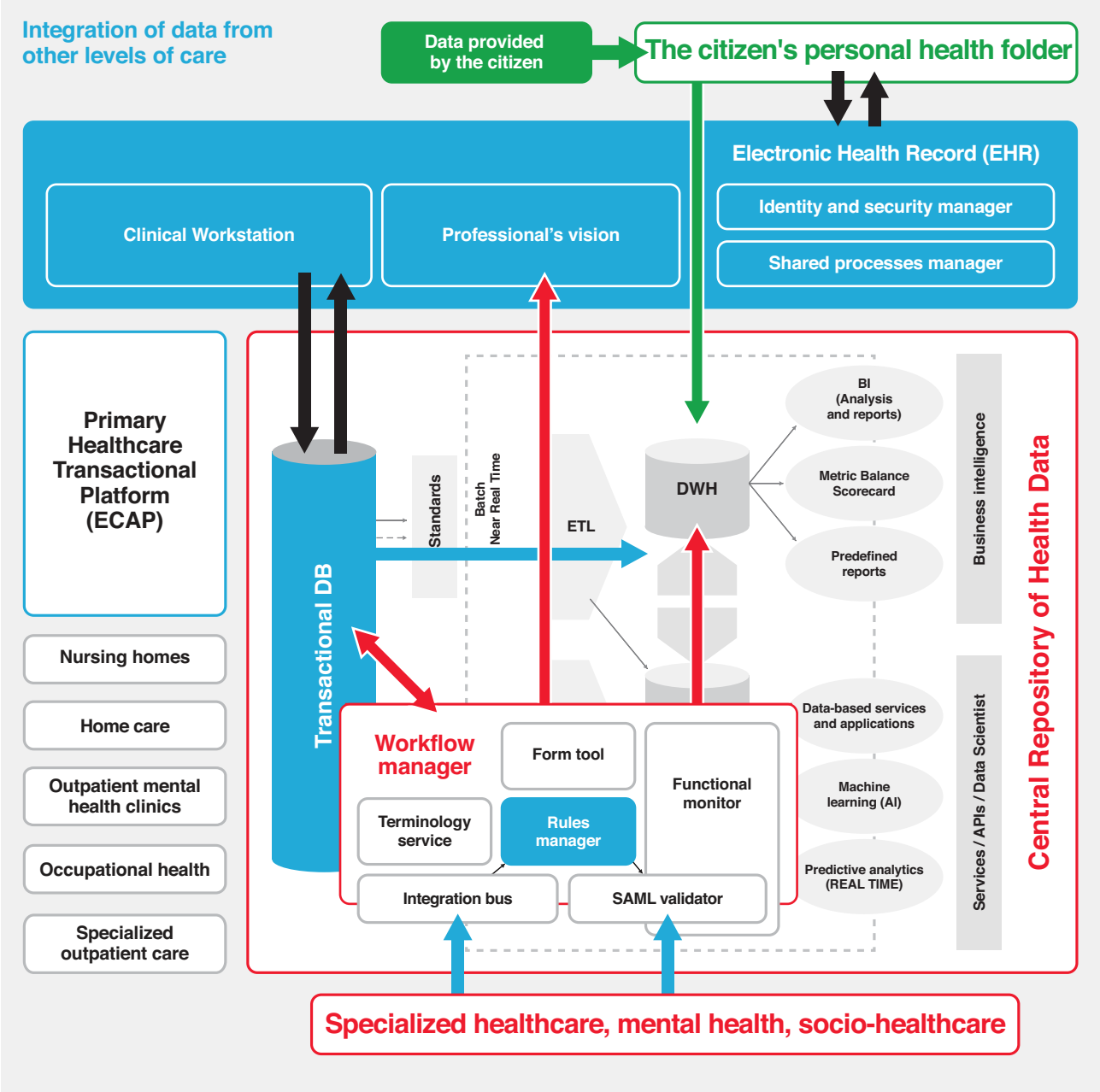
In the **second phase**, the information from the shared health record of Catalonia (HC3), or its evolution through the Electronic Health Record and the unified catalogues, will be integrated into the repository and the presentation layer. Together with the characteristics of access control and identity management, and the remaining operational functionalities, it will become the new Clinical Workstation for Primary Care.

Throughout the process, different units will be developed for other specialized users (nursing homes, outpatient mental health clinics, intermediate care, occupational health, and even specialized outpatient care) and presentation services will be used to integrate the repository with the citizen's personal health folder (currently La Meva Salut).

Integration with the EHR



In the **third phase**, the information sent by other levels of care through the current interoperability tools (IS3) or through the new workflow manager will enrich the transactional data model corresponding to primary healthcare.

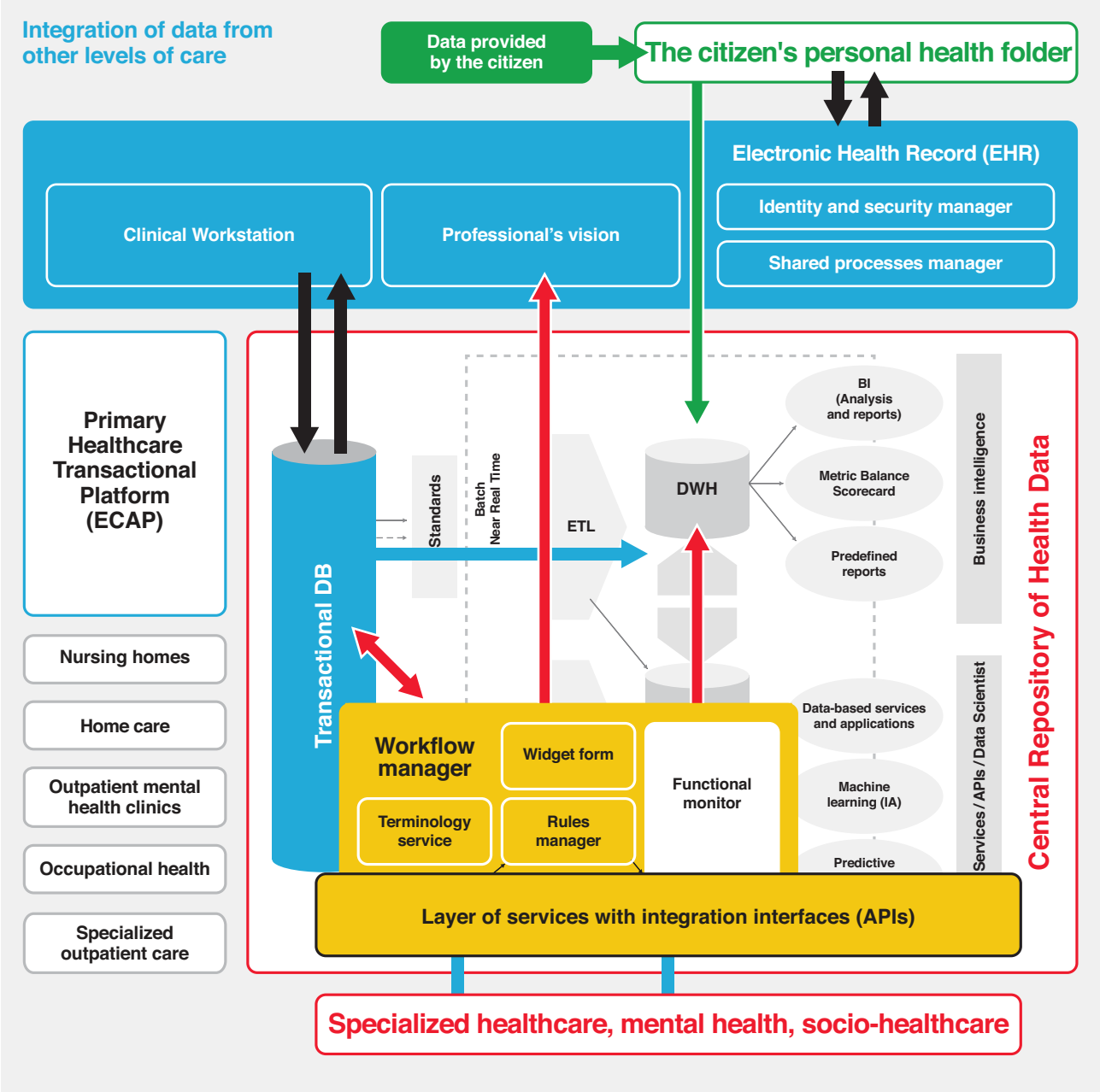


"The basis of data management is to have 'one sole truth,' so we can all name things the same way."

Hospital Physician.

As we indicated in previous chapters, the EHR entails, on one hand, the creation of a **shared language** (functional aspect) in which all agents use the same clinical terminology and coding. Therefore, all of them share a complete and common catalogue of care services.

On the other hand, the EHR entails the creation of a **data repository** equipped with a transactional storage engine, an advanced analytical structure, and the power to create structured data warehouses and unstructured data warehouses (Data Lake).


Integration of data from other levels of care
Data provided by the citizen
The citizen's personal health folder
Electronic Health Record (EHR)
Clinical Workstation
Professional's vision
Identity and security manager
Shared processes manager
Primary Healthcare Transactional Platform (ECAP)
Nursing homes
Home care
Outpatient mental health clinics
Occupational health
Specialized outpatient care
Transactional DB
Standards
Batch
Near Real Time
ETL
DWH
BI (Analysis and reports)
Metric Balance Scorecard
Predefined reports
Business intelligence
Workflow manager
Widget form
Terminology service
Rules manager
Functional monitor
Data-based services and applications
Machine learning (IA)
Predictive
Services / APIs / Data Scientist
Central Repository of Health Data
Layer of services with integration interfaces (APIs)
Specialized healthcare, mental health, socio-healthcare

Technological architecture of the data repository

Schematically, the technological platform on which the Central Repository of Health Data [*Repositori Central de Dades Sanitàries* (RCDS)] is developed offers the following services:

- Web presentation and API management services.
- Implementing a first level of presentation standard and API.
- Authentication services.
- Access management.
- Clinical terminology server.
- Structured and unstructured databases for event recording and transactional states.
- Unstructured databases for external data storage.
- Data Warehouse and Data Lake management platforms (data integration, staging, and analysis).
- Base set of analysis tools.

Workflow Manager

"The data model has a dynamic part, which shows the change of state and the movement of the patient within the system."

Primary Care Physician.

A key objective of the EHR is to facilitate a patient's transfer between different health services and follow-up by the professionals involved in the process and by the patients themselves. This is the goal of the **workflow manager**, which is an evolution of the current interoperability platform (IS3).

The new workflow manager is part of the basic core of the EHR:

- **Transactional:** as a repository of process definitions and to integrate the care data associated with each stage of the process (for example, the fact that a referral includes the relevant clinical documentation for the professional on *push* mode).
- **Analytical:** to be able to perform analysis on the activity registered by the manager itself (process mining).

Technologically, this line of work involves selecting and implementing a **workflow management tool** that is built into the rest of the architecture.

New personal health space for citizens

The integration of all primary care information and the activity of other levels of care in the data repository allows, through its **user-centred** and **multichannel-oriented** presentation layers, the creation of a citizen portal (a health and social space). This portal must allow consultation and access to personalized **bidirectional** services of **information, interaction, and transaction** for the improvement of care provision and the relationship of citizens with the system. The space is considered a unique point of entry, so that, in addition to the common services of the EHR, it also allows access to the information services of the care providers themselves.

In addition, the portal will facilitate the incorporation of data provided by the citizens themselves in a specific EHR space.

In this way, citizens can access their information and provide information to the system, which is visualised in the EHR and enriches the analytical model through a strategy of continuous information flow.

Within this context, the incorporation of open integration services into the presentation layer is considered so that care providers and approved applications can enrich the data model.

Emergency plan for the workplace

This section includes a review of workstation needs for healthcare professionals, in terms of **hardware and software, communications**, and the design and implementation of a modernization process.

The Plan will especially take into account the needs of the continued care teams that work in **mobility**.

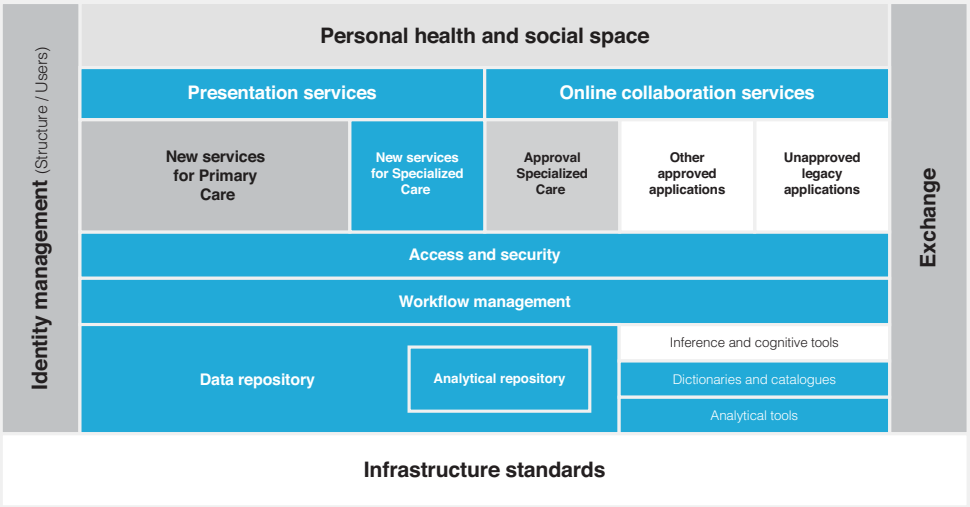
8.5. Actions on hospital care applications (HIS)

As presented in a previous chapter, the Plan does not seek to homogenise the different environments for assistive work of all the entities providing specialised care. Instead, it aims to establish standards and conditions for **approval** of the current workstations through the new HIS (Hospital Information System) and reduce the number of current solutions. In addition, for those care providers who require it, the Plan aims to facilitate their evolution to a more complete and modern solution, perfectly integrated into the proposed new information model.

"It is clear that we have to replace interoperability with the exchange of structured data in real time and the construction of a single repository. But this does not mean having a single HIS."

Hospital IT Director.

HIS scope of action



Homologation of current solutions

Once the technical characteristics of the data repository and the standards for access, security, and presentation services are defined, the objective of this strategic strand of work is to identify the requirements that must be met by specialized care information systems to be able to assimilate into the EHR by exchanging information and processes at the level of detail that is defined at every moment.

The identification of these requirements must be developed together with the inventory of characteristics of the current systems and an **evaluation of the adaptation needs** to have a definition of the approval requirements and the action plans for each platform.

The homologation process will be carried out through the *Oficina d'Estàndards i Interoperabilitat* [Standards and Interoperability Office], which will be provided with the necessary resources to carry out this task and will be advised by professionals throughout the Integrated Public Healthcare System of Catalonia (SISCAT). In general, accreditations will be structured in four areas of analysis:

1. Compatibility of the structure and components of the workstation with the EHR.
2. Communications: connectivity with the workflow manager and adaptation to the data model and dictionaries.
3. Compatibility of presentation services with the EHR viewer for professionals and citizens.
4. Security and data protection.

The homologation criteria for information systems will be part of the **accreditation model** of the healthcare centres of SISCAT. They will represent just one more section of the overall outcome of the process, with the usual qualification criteria of the current model, in which a minimum global qualification is required to be able to work as a care provider in the public health system.

The process may include, other than approval or homologation, **advice to the care provider on technical or economic aspects** such as the flexibility and the evolution capacity of the platform, the maintenance costs, the solvency and positioning of the manufacturer, or the availability of services in the market.

New reference HIS

"The conditions for the approval of solutions will be a basis for choosing a reference solution, but they have to work in much more detail."

Hospital IT Director.

This strategic line of work aims to address the construction of a modular transactional system that works on the EHR data model and technological standards. Thus, as in the case of the new ECAP, the transactional database of the new HIS is that of the central repository of data and allows the introduction of clinical data in the EHR in real time.

This system aims to provide a comprehensive response to care providers that cannot afford to maintain and/or evolve their current system, and to facilitate the change to the new solution for those who, for a variety of reasons, want to benefit from it. The Plan considers the provision of **end-view incentives** for care providers who want to do so.

The technological and functional architecture must be as modular and uncoupled as possible, as well as capable of being integrated through **open application interfaces (APIs)**. This way, care providers who want to maintain their solution can adhere to some of the modules (such as, for example, nursing, outpatient, operating rooms, pharmacy, etc.). On the other hand, the separation in modules will facilitate their gradual development and implementation.

The most important conclusions of the working group in relation to the **technical and functional characteristics** that the new platform will have to achieve were presented in the chapter on work environments (chapter 5).

Next, a design group must be formed for the **functional, technical, and economic evaluation** of the specialised solutions that exist on the market, and to assess the convenience of establishing agreements with manufacturers or, instead, developing a customised solution.

The decision of developing or buying

Although most of the service-providing entities use manufacturer systems, and that the analysed reforms of healthcare systems seem to favour this choice, there does not seem to be a consensus among the professionals of information systems of the Integrated Public Healthcare System of Catalonia (SISCAT) about this being the best solution for the future.

Those against this option use arguments such as **functional adaptation** to the specificities of work processes, **flexibility** for growth, and integration, both internal (between functional modules of each institution) and external (with primary care or other centres). They also mention **ergonomics** and **data management** (difficulty in accessing and exploiting the database from other applications, adapting to the architecture proposed by the EHR). Other arguments against this option com from an **economic** standpoint (model and costs of licensing, maintenance, and migration), and from a **managerial** one (lack of presence in the local market of some of the specialised manufacturers and consultants and implementers trained in their tools).

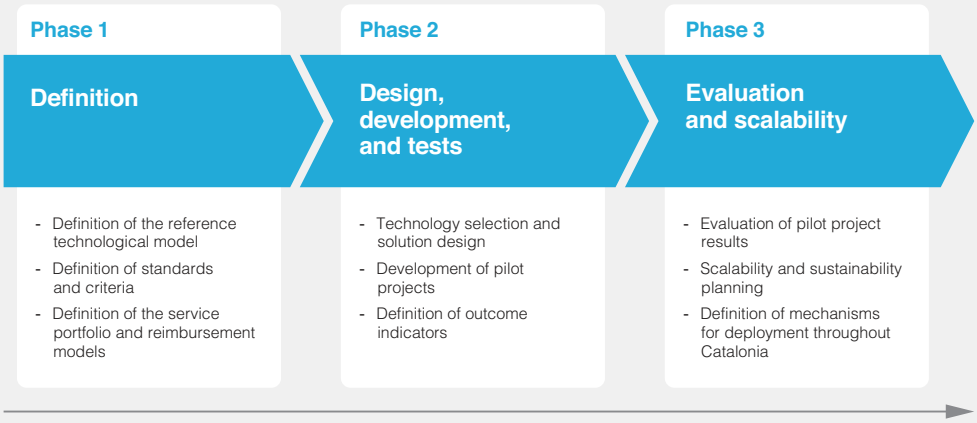
This uneasiness can open opportunities to consider the customised development of a competitive solution based on open technologies and adapted to the needs of the sector and the proposed model in the Master Plan.

The decision between developing and buying is one of the most critical and far-reaching ones in the world of computing. It will require careful analysis, tests, and evaluations that take into consideration many dimensions at the same time.

8.6. Innovation management

Unlike previous initiatives, innovation management is based on creating and encouraging an **open collaboration and sharing environment** of the initiatives that are developed at the local level and in defining mechanisms that facilitate extension throughout Integrated Public Healthcare System of Catalonia (SISCAT).

Outline of the innovation management model



First of all, initiatives that add value and new services to the Electronic Health Record will be prioritised, such as:

- Advanced data analysis tools and Big Data.
- Platforms aimed at supporting new healthcare models based on Telehealth and Mobility.
- Systems based on the integration of the Internet of Things.
- Artificial Intelligence models and tools.

Projects that, in an objective and auditable way, improve a clinical process or, better yet, facilitate their redesign will be prioritised second.

The purpose is to establish **a model of experimentation, evaluation, and approval** with the following key features:

- Defining specific projects that aim to define health models with components of remote healthcare delivery. These projects must be considered from a **co-creation** perspective between **professionals and citizens**.
- Working in an environment of **shared experiences and practical improvements** with a continuous communication process and a management model for apps and API.
- Defining **communication channels between the different stakeholders**: professional to professional, professional to citizen, citizen to citizen.

8.7. Governance and financing model

In the previous chapter, we defined the required characteristics for the model of ICT governance and financing of the Integrated Public Healthcare System of Catalonia (SISCAT), as well as the need to establish a structure for its management.

The development model **must be done in parallel with the deployment of the new projects and services** considered in the Master Plan, and the **reorganization of the current competencies** of the different bodies and corporate agencies within the Ministry of Health:

- Creation of the **ICT management structure** and establishment of its competences. There is a need to establish, as soon as possible, its role, organic location, and the provision of an initial critical mass of resources.

- Establishment of the **member-based participation bodies**, both for the execution of the Plan and for advice in specific areas, such as the *Oficina d'Estàndards i Homologació* [Standards and Accreditation Office].

- Creation of the ***Oficina del Pla Director*** [Master Plan Office] and preparation of an **executive program** for the deployment of the program. The Master Plan is a complex and multidimensional program that requires transversal abilities and competencies beyond technical capabilities. The Master Plan is also a strategic framework, but it cannot replace a detailed executive program that is assessed in matters of time and finances.

- Preparation and approval of the **Financing Plan** of the program, and allocation of economic resources to the different projects and services. Ideally, this should be a multiannual and end-view program.

- Establishment of the **governance and data management role** with respect to the current services of Catalan Health Service. The focus of the Planis on data management, an area in which complex management must be established, based on the orchestration of widely diverse resources and competencies.

- Establishment of the ***Oficina d'Estàndards i Homologació*** [Standards and Accreditation Office] and of the advisory and training bodies in line with the sector.

- Design and documentation of **basic processes and methodologies** for managing each area. Since this involves developing a new role that draws on diverse human resources – which are not used to working together or do not always relate hierarchically to each other – establishing shared work policies and processes is key.

- Review of the **relationship model with the Telecommunications and IT Centre of the Government of Catalonia (CTTI) and the reference care providers**. The characteristics of the healthcare sector, and the fact that many of the Plan's projects affect entities that are fall beyond the organic scope of the Government of Catalonia, will require the definition of a new frame of reference for the provision and management of products and services.

- **Progressive formation of the working teams** that will be responsible for the services derived from the projectos of the Master Plan, once they are brought into production. The aim of the Plan is to work through projects to the greatest extent possible. Many of these projects will be implemented outside the scope of the central ICT management structure, while others will become common services, such as those of the Oficina eSalut [eHealth office]. Each time a project goes into production, the structure for its management, maintenance, and evolution must be established.

"Who is going to be in charge? Will there be money? The answer to these questions will determine the credibility of the plan within the system."

Manager of a health sector partnership.

In this chapter, we presented the key features of the implementation approach of the Master Plan. This approach should subsequently be put into practice through an **executive program**, the creation of the **ICT management role and structure** in the Integrated Public Healthcare System of Catalonia (SISCAT), and through **a stable financing framework**.

We also highlighted the critical success factors, especially those that involve organisational, cultural, and human components of change management.

We presented the model for the general development of the Plan, which is organised in **five core ideas**. The most important one is the design and development of the different components of the **Electronic Health Record**, to keep it in step with the evolution of the **new Clinical Workstation for Primary Care**.

Within the EHR, we expounded the design and construction of the **data model** both at a transactional level and also as a model for data storage, **management**, and **analysis**. This requires a series of short-term actions in order to put at the community's disposal some value services and to progressively replace the processes of record sending through different circuits.

The proposed **implementation model** is not that of a linear engineering. Instead, the goal is to work simultaneously in strategic projects that act as a lever for change, in improvements for current projects and services, and in immediate actions and decisions, including the suppression of services and workflows that do not add value.

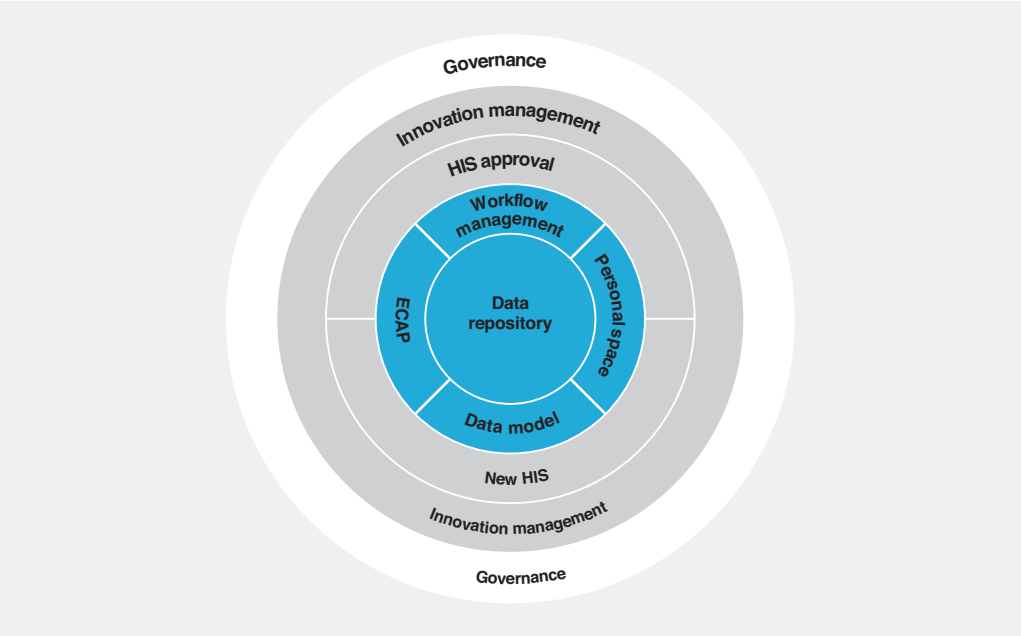
9

Next steps

9. Next steps

For the implementation of the Plan, an ambitious, yet flexible and realistic **executive program** was established. One that considers working simultaneously in strategic projects that act as a lever for change, in improvements on current projects and services to make them converge with the future model, and in immediate actions and decisions such as the suppression of services and workflows that do not add value.

This chapter describes the immediate actions that were planned to undertake the Plan. The structure of the different blocks or areas of action corresponds to what was presented in the previous chapter.



9.1. Presentation and discussion within the sector

Visit the Master Plan website at

http://pdsis.blog.gencat.cat.

As it happened throughout its design, the Plan aims to be a vehicle for communication and the creation of agreements within the sector, both in the field of ICT professionals and beyond – with healthcare and management professionals – to ensure their effective involvement and leadership.

In addition to the **development of formal mechanisms for participation and advice**, which we will refer to in the following section, a range of presentation and discussion actions was planned:

- The Ministry of Health has launched a **website** (*http://pdsis.blog.gencat.cat*) where one can find additional results of the work that has already been carried out,, such as those of the Participatory Conference, of the Analysis of International Trends for the reform of information systems in the healthcare sector, and,

especially, of those of the fifteen working groups. These working groups have devised the deployment plans of all the strategic initiatives in the Master Plan, and of the executive program, for their implementation. The main projects and outcomes will be also published there.

- The website itself includes a public space and a private email address for **comments, questions, and clarifications**, and it encourages the publication of articles or works related to experiences in data management and technologies.

- A **launching event** is planned for everyone who has participated in the different phases of the Plan's design, as well as **specific meetings** with associations that represent the sector and professional bodies.

9.2. Governance and financing model

The first set of objectives is related to the need for a **stable governance structure** for operational programming, resource allocation, and the management of different projects and services. As explained in Chapter 7 (on governance), the Plan's governance is a combination of executive, participatory, and advisory bodies.

"Governance means allocation of responsibilities."

Director of an integrated service provider.

The ICT steering committee in the healthcare field

The ICT steering committee in the healthcare field will include members from existing bodies, such as the General Coordination of ICTs, the eSalut office, and information systems management of Catalan Health Service as a key body in data governance. It will also have other ICT competencies that may currently be scattered across other bodies of the Ministry of Health and attached agencies. The roles of this committee involve the following areas:

- **Plan Management.** The main mission is the implementation and monitoring of the different projects of the Health Master Plan. It will have a support office and a group of project managers that will work with CTTI resources, as well as reference care providers and professionals from the service-providing entities assigned temporarily or on a part-time basis. Each project will have an ad hoc structure for advice and functional and technological monitoring. Throughout the implementation of the Plan, the **ICT Strategic Board** will continue to be active, formed by information systems directors from different service-providing entities pursuant to the Resolution of the *Secretaria General del Departament* [the Ministry of Health's general secretariat] of November 2016, which has been in charge of its design.

- **Data governance.** The Chief Data Officer must develop coordinated data management that allows for unique semantics throughout Integrated Public Healthcare System of Catalonia (SISCAT). This management must also ensure that the evolution of the definitions of the data repository throughout the deployment of the Plan is cross-cutting to all the initiatives and projects of the Plan.

"Financing is the vehicle to allocate resources to serve given policies. Therefore, it makes sense to stimulate the change of data and technology management according to the Master Plan and finance central and local initiatives that are aligned with the Plan."

A manager of Catalan Health Service.

This goal has different dimensions:

- The first dimension is related to care and must allow for common catalogs and ensure that the repository responds to the care and management needs that arise at any given moment.

- The second dimension is technical. It must establish communication standards in the new EHR data architecture.

- The third dimension is responsible for the analytical model and the development of data products and services for Integrated Public Healthcare System of Catalonia (SISCAT). As a support body for its performance, a technical advisory body will be created regarding standards and certification, with involvement by professionals from the sector.

- The fourth dimension corresponds to services management. Currently, both the eHealth office and IT departments of Catalan Health Service, the Ministry of Health, and other affiliated agencies already provide internal services and other common or coordinated services throughout SISCAT. The work plan for projects proposed in the Master Plan will gradually add new services to the system once they go into production. It is therefore necessary to develop a role for the management of these products to ensure operationality, maintenance, and evolution. This group is also responsible for establishing contracts and service levels with the CTTI and the care providers and monitoring compliance.

Executive program and budget

In parallel to the formation of these executive and member-based bodies, a revision and adjustment of the executive program must be carried out, realizing the objectives and scope of each project, its internal organization, the execution schedule, and its economic valuation. A financing model that considers the characteristics we have shown in the previous chapter must also be established.

9.3. Construction of the data repository and development of value-added data services

This set of objectives is aimed at developing the technological base of the data repository and basic services to access it with the appropriate security levels. On this technological basis, the data of all current interoperability systems will be integrated so that an initial information platform can be published throughout Integrated Public Healthcare System of Catalonia (SISCAT).

This area is initially structured along the following lines of work:

- **Bases of the model and data governance.** Working on historical data of sufficient quality and with known structures makes it possible to pragmatically address the construction of the data model, both from a functional and technical point of

view, and its governance. As indicated in the previous section, ICT management specifically includes the role of data governance, which must provide a holistic approach to manage, improve, and leverage data. In this way, it will be possible to improve decision making and manage knowledge about information.

- **Design of the target EHR technological architecture.** First, the aim is to have a description of the elements that make up the technological architecture of EHR to implement them in the development of different projects. A detailed analysis of the functional objectives of the new architecture will be carried out, with an emphasis on the requirements related to relational and non-relational database services, data access and persistence, dictionaries, workflow, presentation and basic data ingestion tools, and data transformation and analysis. Also, as a conclusion of the design, the specific requirements for compliance with personal data protection legislation will be identified.

- **Publication of structured information available throughout SISCAT.** As soon as it is technically possible, current interoperability projects should be focused on the use of the new technology platform. The initial objective should be the integration of all the structured information with as much standardization as possible and grant access throughout SISCAT, through the new presentation tools, to an initial data model. Likewise, the information that is available in the central repository will gradually replace the direct reporting of care providers to Catalan Health Service.

  To achieve this objective, all structured information of the shared health record of Catalonia (HC3) and the interoperability platform (interoperability platform (IS3)) interoperability platform (IS3) must be integrated into the new central data repository. The information from the CMBD must also be integrated and ensure that EHR services become the clinical terminology server and central care catalogue.

- **First draft and publication of the *Repositori Central de Dades Sanitàries*** (Central Repository of Health Data [Repositori Central de Dades Sanitàries (RCDS)]) [central repository of health data]. Taking advantage of the analytical infrastructure currently available to the Ministry of Health, in the first stage it will be made to evolve into a classic data warehouse environment in order to achieve the construction of an analytical environment that responds to the need for near real time information.

  To achieve this and ensure the usefulness of this first version, the current analytical projects of the Ministry of Health, Catalan Health Service, SEM, and the remainder of SISCAT's public bodies will be aligned.

- **Publication of the new advanced analytical environment.** Based on the designed data analysis infrastructure, integration of currently available data, and the possibility of including data of a different nature (external data ingestion), a series of initial use cases will be defined and the result will be made accessible to all SISCAT stakeholders. Integrated into the governance model, the method of evaluating opportunities for using these tools and the evolution process of tools and solutions that allow the modular and cooperative development of this environment will also be defined.

9.4. Definition of the new data and workflow model required for the new primary care work environment

"In the design of the data model, professionals from primary healthcare and specialized care must be brought together. They work according to different logics, but they have to complement one another."

Manager of an integrated service provider.

One of the objectives proposed in the Master Plan is the construction of a **new work environment for primary care** adapted to the new ways of working and new care models, with improvements in usability and a more robust technological infrastructure that eases access for professionals to the information they need at all times. The new ECAP database is the basis for the construction of the Electronic Health Record.

Given that the data and workflow model is a common tool for the entire healthcare system, specialized care professionals and other healthcare areas will also participate in its design.

- **Creation of the design group.** The first action is the establishment of a specific technical and functional working group for the design of the **ECAP technological architecture evolution project** and for its merger with the the shared health record of Catalonia (HC3) as the first phase of the construction of the EHR. From the integration of the ECAP **data model**, this group will be responsible for the development of the new environment in primary care integrated into the EHR.

  This group will also define the **workflow manager** as a key tool for monitoring the continuum of care, as well as **collaborative work** functionalities that allow making annotations and comments on healthcare information which facilitate direct communication between professionals.

- **Publication of the data model and workflows from the ECAP to the EHR.** The current data model will be mapped and the **design of the new data model** developed, which will be the core of the central repository. An additional plan is to analyze and execute the process for the **incorporation of information from other levels** and care processes until a complete and consistent primary care information environment is available.

- **New workflow manager.** The new technological architecture must envisage the implementation of the new workflow manager, which will allow for a platform with the levels of scalability, reliability, performance, and functionality required to act as a backbone of the Integrated Public Healthcare System of Catalonia (SISCAT) processes, together with a technological evolution of the current interoperability platform (IS3).

- **New personal health and social space for citizens.** The availability of information on primary healthcare and other levels of care will allow the citizen portal to evolve, which is currently La Meva Salut [the citizen's personal health folder]. In addition, the data model of the repository can be enriched by incorporating health information provided by citizens themselves.

- **Design of the Emergency plan for the workplace of healthcare** professionals and initial changes to the provision of technical infrastructure of hardware, software, and communications, with an initial focus placed on continued care teams working in mobility.

9.5. Approval and new specialized care environment (HIS)

The objective of this area is two-fold. On the one hand, it involves establishing the approval factors and processes for the current management systems and, on the other, opening the work process for the construction (or acquisition) of a new HIS.

- **Creation of the design group.** The first action to be carried out is the creation of the technical and functional groups responsible for this line of work.

- **Detailed definition of accreditation criteria.** This objective envisages, on the one hand, a detailed recognition and evaluation **of the current situation** within the service-providing entities and, on the other, the definition of **functional, technical**, and **security** accreditation criteria to ensure compatibility with the new eHealth record. A gap analysis and an analysis of the opportunity and effort required will be established.

- **Transfer of data to the EHR.** The first step for approval will be the **standardization of content**, so the current transfer of data to the different systems of the Ministry of Health and Catalan Health Service will be replaced by an integration of data in the EHR repository in accordance with the new standards.

- **Selection of alternatives for a new HIS.** According to the recommendations of the strategic initiative working group, the process must be open to different options that must be carefully analyzed at this initial stage. In any case, all options must meet established approval criteria.

    - Explore **commercial solutions** that can be implemented more quickly, establishing a global agreement with the manufacturer.

    - Explore the possibility of developing a **customized** HIS, with a collaborative development agreement between an industrial provider and professionals of Integrated Public Healthcare System of Catalonia (SISCAT).

    - Evaluate the possibility of reducing the number of current platforms through **convergence** between hospitals that share the same commercial base product (SAP, SAVAC, HP-HIS, among others).

9.6. Implementation of an innovation management model for the entire system

Within the scope of the governance structure of ICT management, and based on the review of the roles of current stakeholders and ongoing initiatives, an **initial model** will be defined that allows the evaluation and management of initiatives and facilitates an environment for sharing knowledge and experiences to Integrated Public Healthcare System of Catalonia (SISCAT).

Subsequently, the specific initiatives corresponding to Telehealth and Mobility, Artificial Intelligence, IoT, and eventually other technologies will be handled in accordance with the criteria described in Chapter 6.

Models of **innovation networks** will be established as virtual communities to know and manage, in an integral way, the processes of creation, development, and application of the innovative ideas for the professionals with the different SISCAT care providers.

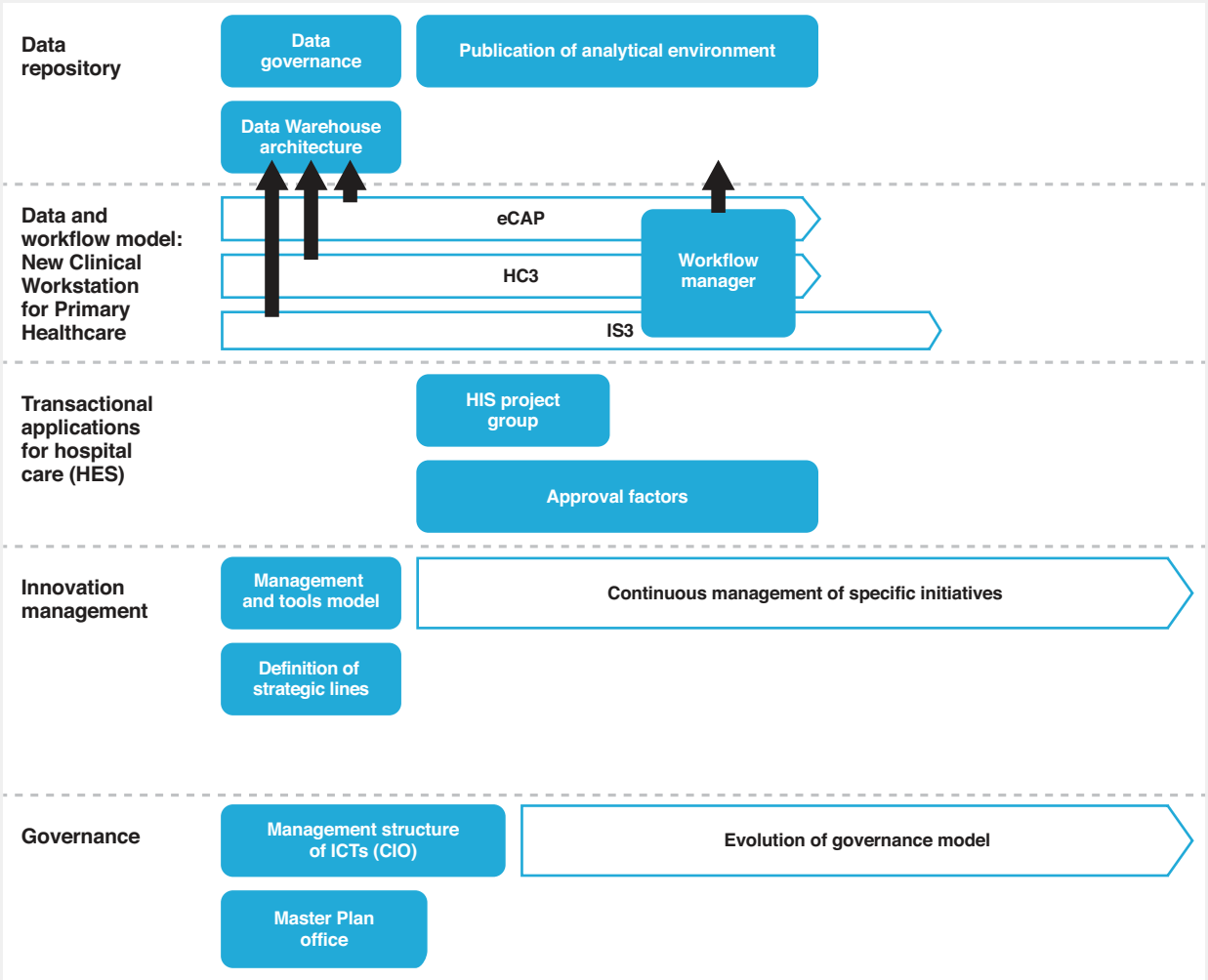
"We must be able to find a couple of short-term success opportunities and spread them quickly, maybe in the field of mobile applications or in some telemedicine projects."

A manager of Catalan Health Service.

The model graphically shows the implementation process of the Master Plan, with the initiatives planned at an initial stage. The process will benefit from initiatives and services that are already evolving and improving, such as the ECAP or the interoperability platform (IS3). Above all, the model aims to take a significant step forward in the construction of the analytical repository and its publication throughout SISCAT.

Also, the central executive and member-based structures of communication, governance, and financing are developed in this initial stage.

Outline of Stage 1



Annex I. Executive program

A.1. Introduction

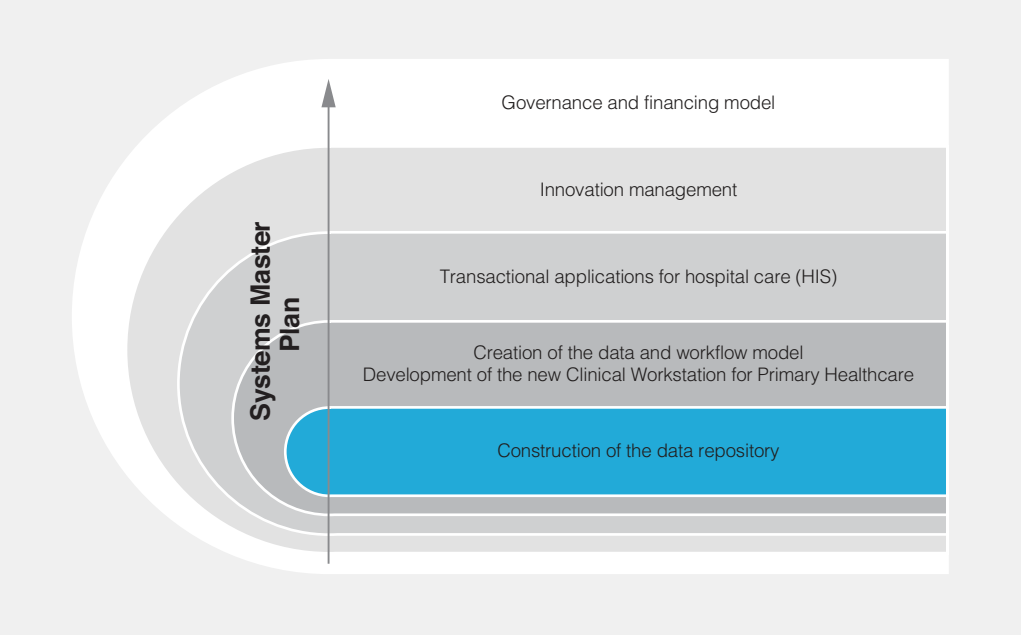
A.2. Five areas of activities

A.3. Implementation stages

Annex I.
Executive program

A.1. Introduction

This chapter will describe concrete actions for the development of the five areas of activities in the Implementation Plan identified in Chapter 8. The definition of the areas corresponds to different work areas, which are interrelated and evolve towards the vision for the future of the EHR. The chronological relationship of the execution of the different actions in each area is clearly outlined in section 9.3.



- **Construction of the data repository.** The first area defines the creation of a **data repository** with the information currently available in the system in a scattered manner and which comes from different sources. In practice, it happens to be most of the information that will be available in the data model. This repository will become the embryo of the central repository of health data (Central Repository of Health Data [Repositori Central de Dades Sanitàries (RCDS)]).

- **Creation of the data and workflow model and development of the new Clinical Workstation for Primary Care.** The second area aims to provide structure and a vision for the future of the EHR based on **the transformation of the Clinical Workstation for Primary Care** (ECAP). Its database will be fully integrated into the common repository of the EHR. The core of the EHR also includes the **workflow manager**, which is part of this area of activities.

- **Transactional applications on hospital care (HIS).** The third area includes the actions on applications for the management of specialized care. It begins with the definition of an **approval process** of the current **clinical workstations** (of its structure, information exchange standards, and security) to ensure compatibility with the EHR. In parallel, the process of design and construction (or acquisition) of a new reference tool, **a new HIS**, is launched for care providers that require such use or want to make the shift.

- **Innovation management.** The fourth area consists of an innovation empowerment, sharing, and **management** process throughout the system, focused mainly on those tools that reinforce the defined information model (such as Big Data, the Internet of Things, Artificial Intelligence, and Telehealth and Mobility).

- **Governance and financing model.** The fifth area is made up of **governance** policies, structures, and mechanisms and **financing of the Plan**, which will be deployed throughout its execution.

This description of actions is a first prioritization of objectives to be achieved in the medium and short term, striking a balance between the importance of developing the Plan, the need to focus and coordinate efforts, and the opportunity to offer new digital services to all SISCAT users in the shortest possible time.

A.2. Five areas of activities

Governance and financing model

A. Establishment of the governance structure for ICT management

The first set of objectives is related to the need for a stable governance structure for the strategic definition, project management, and resource allocation of the different ICT projects. It must also allow the coordination of activities and the integration of the projects that are in progress at the beginning of the Plan's rollout.

This governance structure will include the General ICT Coordination, the current eSalut Office (in charge of the management of cross-cutting SISCAT ICT projects), and the Information Systems Management of Catalan Health Service as a key body in data governance falling under the CDO (Chief Data Officer).

The role of the ICT management governance structure is to establish the financing and resource needs for the Plan and all the bodies that fall under it.

B. Establishment of the Master Plan Office

This office will be responsible for executing various projects, allocating resources, and monitoring the Plan. This structure must be integrated into the SISCAT Information Systems administration, so that all strategic initiatives are developed through its management.

This office is considered key for the management of the Plan and is a basic prerequisite for the development of the remainder of areas of activities, together with a stable financing structure for the evolution of the Plan.

C. SISCAT participation bodies

The model of participatory governance defined in Chapter 8 emphasizes that this governance must necessarily combine management, leadership, and regulatory authority components with participation and advice components among the managers and specialists within the Catalan healthcare system. This is where the different participatory governing bodies of SISCAT are defined.

First, SISCAT's ICT Strategic Board is consolidated as a technological advisory body of the current General ICT Coordination of the Ministry of Health.

Second, the creation of an advisory body for the functional evolution of ICT projects is envisaged, consisting of care, technology, and management professionals representing different SISCAT care providers and care

levels. In this case, the role of the system's managers (UCH, CSSC, and ICS) is seen as crucial.

Finally, a supervisory and advisory body for the execution of the Plan is defined, which will be directly related to the Plan Office.

D. Standards and Accreditation office

The integration of data in the single EHR repository requires coordinated data management that allows for unique semantics throughout SISCAT and ensures that the evolution of the definitions of the data repository throughout the deployment of the Plan cuts across all concrete initiatives. This objective is two-fold. The first one, which is care-oriented, should allow for the availability of common catalogues and ensure that the repository responds to the clinical and management needs posed at all times. The second one, which is technical, must establish the communication standards for the new EHR data architecture.

The Standards and Accreditation office will fall directly under ICT governance structure management.

Although the CCTI is responsible for ICT management of the affiliated bodies of the Government of Catalonia, it is important to carry out the revision of the current service provision contracts so that optimal levels are defined for healthcare support and the quality of services provided by the EHR can be ensured from the outset.

Construction of the data repository platform

This set of objectives seeks the creation of the technological base of the data repository and basic services that comprise it, as well as the security layer. The data of all current interoperability systems will be integrated in this technological base to develop an initial information platform for all of SISCAT.

A. Data governance

ICT governance specifically includes the role of data governance, which must be built on a holistic approach to manage, improve, and leverage data. The objective is to focus on the improvement of decision-making and the management of information knowledge. The role of data governance is to manage data as an asset within the organization that provides value and ensures strategic alignment with the Plan.

B. Design of the EHR target technological architecture (Central Repository of Health Data [Repositori Central de Dades Sanitàries (RCDS)])

A functional analysis of the new architecture will be carried out with a detailed description regarding relational and non-relational database services, data access and persistence, dictionaries, workflow, presentation and basic ingestion tools, and data transformation and analysis.

In the first stage, the analytical infrastructure currently available to the Ministry of Health will evolve into a classic data warehouse environment. Technologically, this architecture will be supported by high-performance and high-compression databases, including high-speed data processing tools to ensure the construction of an analytical environment that gives an operational response to real-time or near-real-time information. The current analytical projects of the Ministry of Health, Catalan Health Service, SEM, and the remainder of SISCAT's public bodies will be aligned.

Also, to conclude the design, the specific requirements for compliance regarding personal data protection legislation will be identified.

C. Publication of the structured information available throughout SISCAT

Once it is technically feasible, current interoperability projects should focus on the use of the new technology platform. The

initial objective should be the integration of all the structured information with as much standardization as possible and to allow all SISCAT stakeholders access to the initial data model through the new presentation tools.

Likewise, the information that is available in the central repository will replace, insofar as possible, the care provider's direct information system with Catalan Health Service.

To achieve this objective, all the structured information of the the shared health record of Catalonia (HC3) and the interoperability platform (IS3) must be integrated into the new central data repository. The information from the CMBD must also be integrated and ensure that the EHR services become the clinical terminology server and central care catalogue.

D. Publication of the new analytical environment

Through the implemented data analysis infrastructure, based on the concept of Data Lakes and Data Warehouses as discussed in previous chapters, a series of initial use cases will be defined and the outcome will be made accessible to SISCAT.

The analytical environment defined will allow a direct transfer of system information to end users such as care professionals, managers, technical secretariats, and SISCAT planners in the time and manner required in each case. The model will be mature for the implantation of Artificial Intelligence solutions broadly across the EHR. These support and assistance tools for decision making will be realized through alerts and notifications in the EHR viewer.

This objective will also provide all professional profiles involved a training program that allows the incorporation of these new tools into their everyday routine.

Finally, and integrated into the governance model, the evaluation method of use cases with these tools and the process of evolution for tools and solutions that allow the modular and cooperative development of this environment will be defined.

Definition of the new data and workflow model required for the new work environment for primary care

The main action in this set of objectives is the establishment of a specific technical and functional working group for the evolution of the technological architecture of the ECAP and its merger with the the shared health record of Catalonia (HC3) as the first phase of the construction of the EHR. Based on the integration of the ECAP data model, this group will be responsible for the development of the new primary healthcare environment integrated into the EHR. This group will also define the workflow manager, which is a key tool in the monitoring of the healthcare continuum.

A. New workflow manager

The ICT governance specifically includes the implementation of the new workflow manager that will allow for a platform with the levels of scalability, reliability, performance, and functionality required to act as the backbone of SISCAT processes, evolving the current architecture of the interoperability platform (IS3).

Functionally, the workflow manager will allow the incorporation of process definition and management information into the data model to be presented to users and exploited in the analytical environment.

One of the objectives established in the Master Plan is the construction of a new primary healthcare environment that allows professionals to access the necessary information in a usable environment that integrates aid tools for carrying out tasks and decision making. The merger of the the shared

health record of Catalonia (HC3) and the ECAP will pave the way for the construction of the EHR.

The first steps for the construction of this new environment are proposed in this series of objectives and will come to fruition through the integration of all the information related to primary healthcare in the EHR data repository, so that this information can be used as new workstations are gradually developed.

B. Publication of the ECAP data and workflow model in the EHR

The new ECAP data model will be designed and linked to the current data model. Synchronization tools and processes will be implemented between the ECAP and the new central data repository so that the two data models are a mirror of the information managed.

Simultaneously, information from other levels and care processes will be integrated into the merger process of the the shared health record of Catalonia (HC3) and the interoperability platform (IS3) until a complete and consistent primary care information environment is available.

Once this integration is available, the presentation layer of the EHR can be used as a Clinical Workstation for Primary Care.

The availability of a viewer including all the information will be complemented by the construction of a communication platform between professionals that replaces the current ones and incorporates functionalities of collaborative work, including annotations and comments on care information.

The availability of all primary care information and other levels of care will facilitate the evolution of the citizen portal. Additionally, the repository data model can be enriched by the incorporation of health information provided by citizens themselves.

Approval and new environment for specialized care (HIS)

This series of objectives aims, on the one hand, to establish the approval factors and processes for the different hospital information systems in operation and, on the other, to describe the line of work for the construction of a new information system for hospitals that can be used by those organizations that need to change the system they rely on.

A. Creation of the design group for the new specialized care environment

This objective is the initiation of work for the technical and functional groups in defining the accreditation process and the new environment based on an analysis of the current situation and the objectives of the new HIS.

B. Definition of approval factors

This objective includes not only the definition of the approval factors according to the design of the new platform and the standardization of the data model, but also the identification of the current situation of the different care providers, as well as the opportunity and effort required to establish a gradual process of approval for different aspects of the HIS.

C. Data transfer to the EHR

The first step of the accreditation process will be the standardization of content, so that current data submissions to the different

systems within the Ministry of Health and Catalan Health Service will be replaced by an integration of data in the EHR repository according to the new defined standards.

Once this integration takes place, the new data requirements should be channeled through the EHR. In this way, the specific data requests to SISCAT care providers can be gradually phased out.

D. Selection of alternatives for a new HIS

Although the development of functionalities corresponding to specialized care will be modular in accordance with the needs identified, it is essential to identify the framework in which the search for technological solutions will be carried out:

- Explore commercial solutions with the objective of reaching some kind of global commercial agreement with comparable solutions which allows offering alternatives to hospitals that decide to implement a new HIS.

- Explore the possibility of developing a customized HIS that meets the approval criteria and which would be integrated into the EHR as a service for hospitals with unapproved HIS.

- Examine how to reduce the number of HIS that currently serve SISCAT and explore the possibility of unifying implementations of the same commercial solution (SAP, SAVAC, HP-HIS, and so on) that is approved by the EHR.

This evaluation should be carried out through the EHR architecture definitions to ensure its integration.

Implementation of an innovation management model for the entire system

An initial model that is based on the review of the roles of the current stakeholders and ongoing initiatives must be defined. This model should allow evaluation and management of the initiatives and make an environment for sharing knowledge and experiences available to SISCAT.

Subsequently, concrete initiatives related to Telehealth and mobility, Artificial Intelligence, IoT, and other possible innovative technologies will be managed in accordance with the objectives of standardization, sustainability, and care value. Innovation network models will be established as virtual communities to comprehensively manage the creation, development, and application processes of the innovative ideas contributed by professionals with the different SISCAT care providers. The platform to manage virtual communities will facilitate having information in real time, offer a global image of the current status of all projects, and efficiently evaluate their viability at each point of the process.

A.3. Implementation stages

The temporary implementation of the activities in the five defined areas will be carried out simultaneously to enable bridging the gap between the current situation and the model proposed for the future. The different activities and establishment of structures that correspond to the five defined areas are grouped in three stages.

Deployment stages for the 5 areas of activities for the execution of the Master Plan

Stage I

In this first stage it is important to align the current projects of the General ICT Coordination of the Ministry of Health, Catalan Health Service, and the eSalut office with the Plan's objectives. For this reason, a core of governance must be ensured as the embryo of the governance structure for ICT management in healthcare. The general ICT coordinator and the Information Systems manager of Catalan Health Service, together with the management team of the eSalut office, will form the central core of ICT governance for the system with the objective of aligning ongoing projects with the Plan's objectives.

This core will define the new ICT governance structure within the framework of SISCAT.

The Master Plan office will be created and different working groups will come from it. Each group will have to be coordinated and will have the support and advice of the CE-ICT and the involvement of the sector.

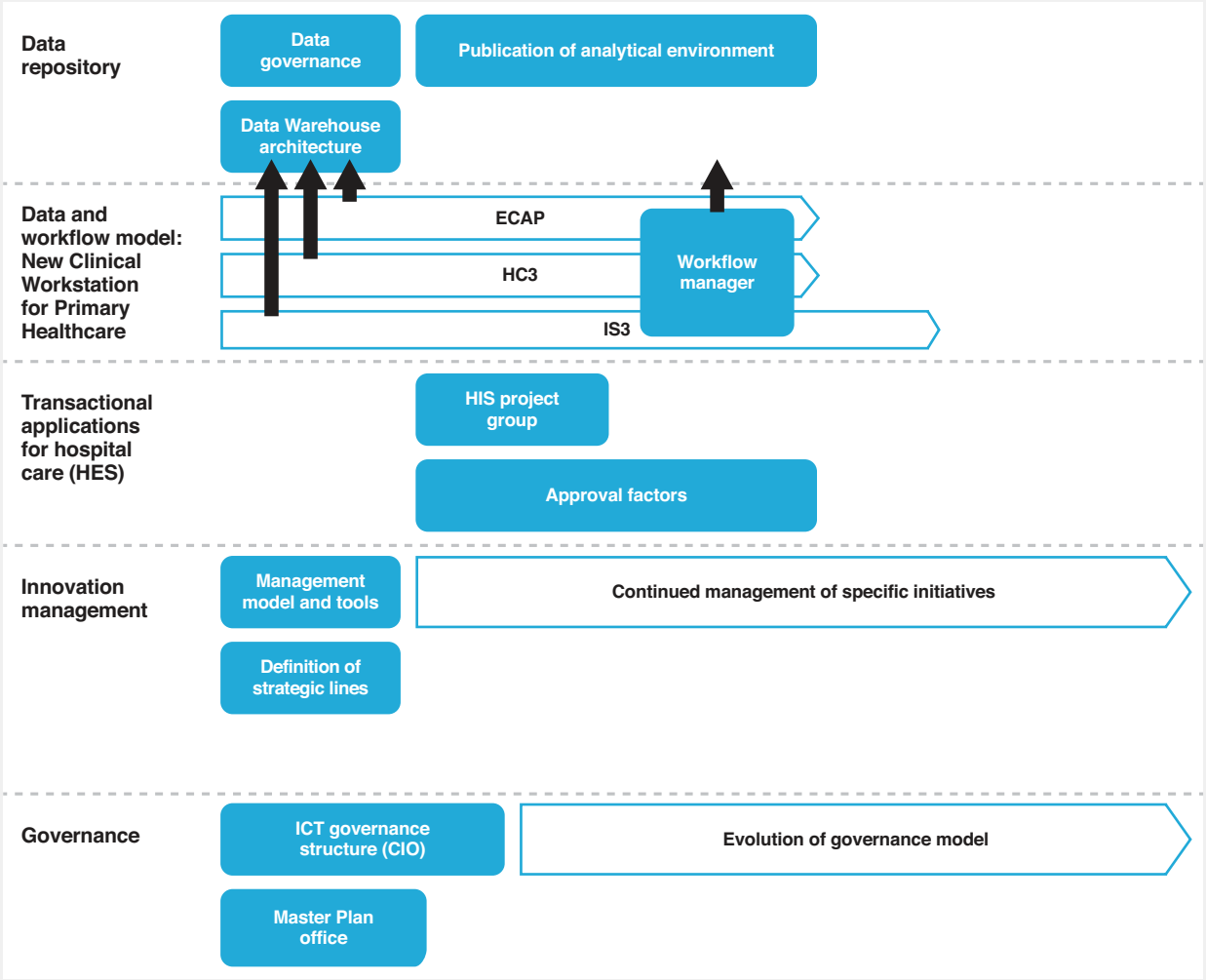
A specific technical and functional working group will be created for the evolution of the technological architecture of the ECAP and its merger with the the shared health record of Catalonia (HC3), which will be the first phase of the EHR construction. This group will also define the workflow manager as a key tool for monitoring the healthcare continuum.

A specific working group will be created to establish the approval criteria for the transactional platforms of specialized care. This group will aim to define the requirements that specialized care information systems must meet to be able to integrate into the EHR, with the exchange of information and processes at the level of detail that is defined at any given time.

In its role as the main stakeholder, Catalan Health Service will work through its Information Systems management to publish the analytical environment on a BI (Business Intelligence) platform. The first action is the construction of the Data Warehouse model (key element of the Central Repository of Health Data [Repositori Central de Dades Sanitàries (RCDS)]) for the processing of the system's structured data. The idea is to gradually decrease the frequency of data transfer by care providers and increase the level of aggregation. Simultaneously, the information derived from the cross-cutting applications managed by the eSalut office (the shared health record of Catalonia (HC3), interoperability platform (IS3), and LMS) will be included in the model.

In accordance with the lines defined by the Plan, the Master Plan office will propose an innovation management model for SISCAT.

Stage I: outline



Stage II

At this stage, the governance structure will establish the participatory bodies and mechanisms for SISCAT in the decision-making of the system's ICT role. The Standards and Accreditation office will be created and will fall directly under the ICT management structure.

Both the implementation of the EHR and the merger between the ECAP and the the shared health record of Catalonia (HC3) will begin in the context of a new technological and functional architecture. The new data model will include information from other levels of care through the exchange of information from the interoperability platform (IS3) interoperability platform.

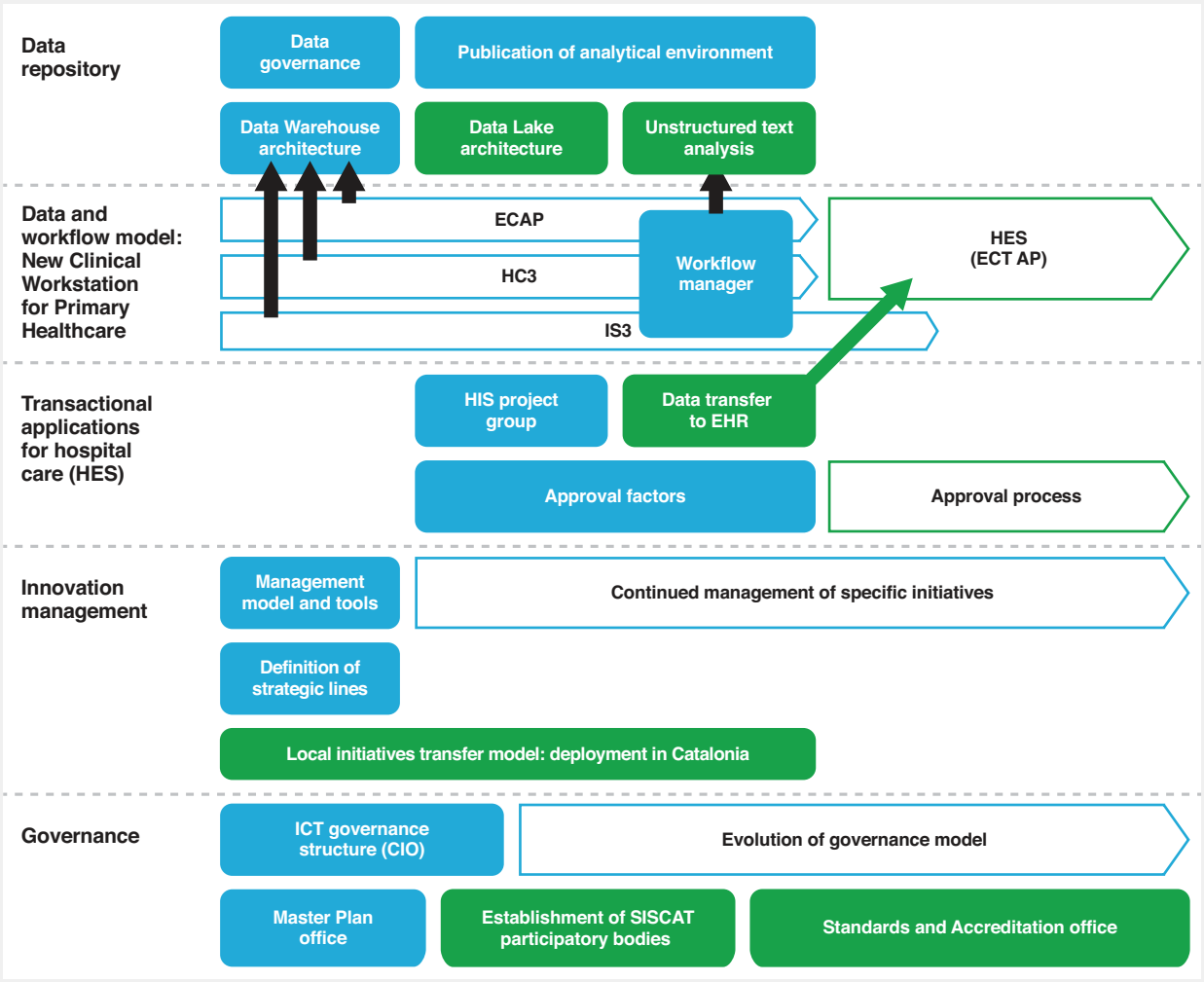
The EHR data model will be replicated in real time at the central repository of health data (Central Repository of Health Data [Repositori Central de Dades Sanitàries (RCDS)]).

Access to the Central Repository of Health Data [Repositori Central de Dades Sanitàries (RCDS)] will be made available to SISCAT care providers, and from there they will be able to access the corporate BI model or, directly, the data model to exploit it and analyze it with the BI tools of each care provider. Simultaneously, the development of the architecture for the unstructured information in the system will begin while following the implementation strategy based on use cases.

The application accreditation processes will also be initiated during this stage. This process will be carried out through the Standards and Accreditation office, which will be provided with the necessary resources to carry out this task.

Finally, the innovation management model will be developed for the transfer of local initiatives to the entire system.

Stage II: outline



Stage III

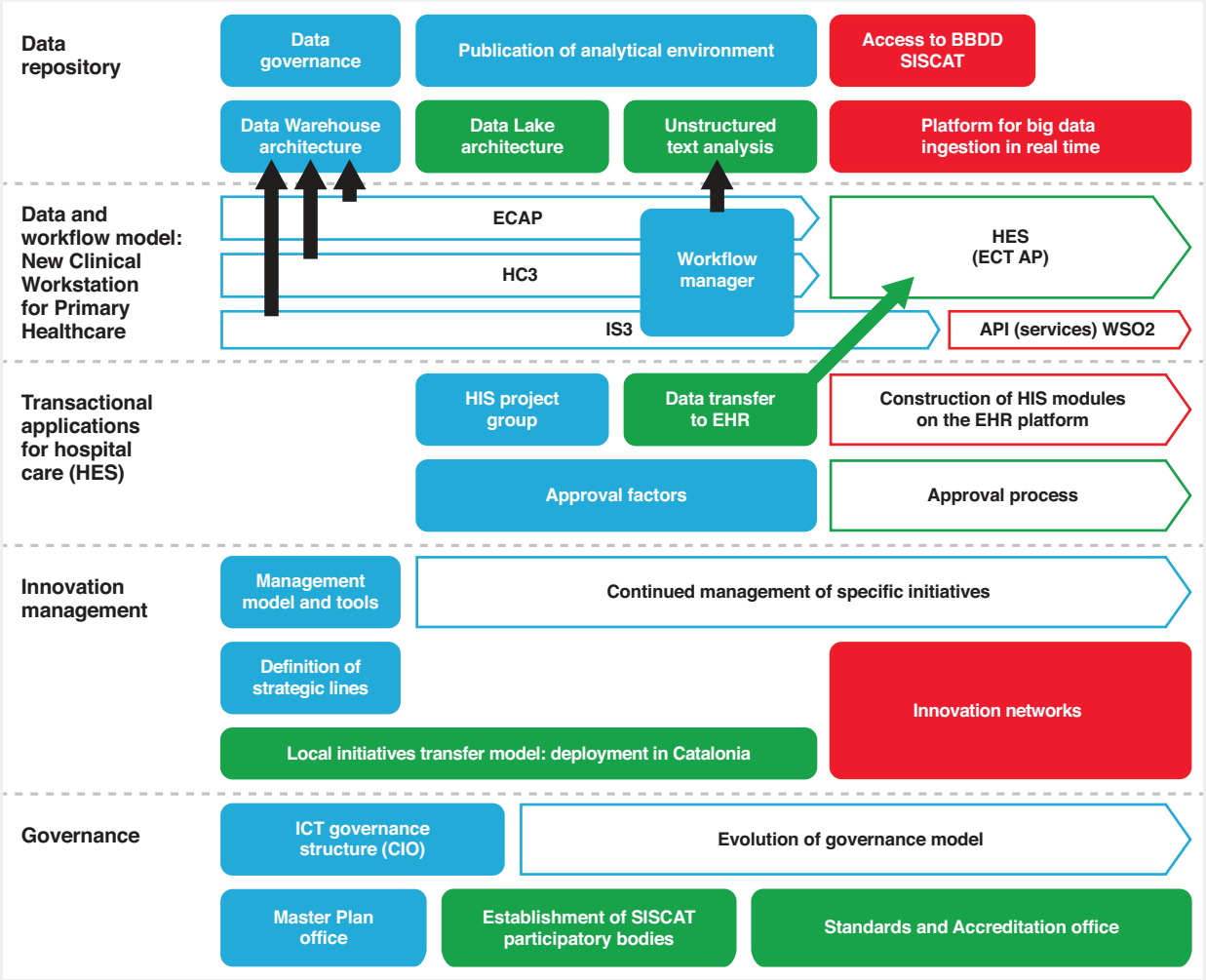
In the last stage, the key elements for the EHR to become the majority transactional platform for SISCAT will be defined so that it can then respond to different care providers and levels of care. This modular transactional and analytical platform will serve all the stakeholders of the healthcare system in Catalonia.

The architecture defined in the Data Lake and Data Warehouse model will be implemented with a direct transfer to the end users, such as care professionals, managers, technical secretariats, and SISCAT planners. The model will be sufficiently mature to be able to the implement Artificial Intelligence tools in a generalized way in the EHR as support and assistance tools in decision making in the form of alerts and notifications in the EHR viewer.

The modular construction of the new hospital information system that will be part of the EHR will begin. The idea is to provide the EHR viewer with clinical workstation functionality that allows the entry of clinical data in real time.

Finally, the innovation network model will be established. Virtual communities will be created through this model to comprehensively manage the creation, development, and application processes for the innovative ideas provided for professionals with the different SISCAT care providers. The platform will provide real-time information and a global picture of the status of all projects, as well as efficiently assess their viability at each point of the process.

Stage III: outline



Annex II. Professionals and participating entities

Annex II. Professionals and participating entities

ICT Strategic Board

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Working group participants

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Acezat, Jordi
Agustín Zaballos, Juan
Arco, Sandra
Barahona, Marta
Barberà, Albert
Barrabés, Domènec
Benavent Navarro, Anna
Benet Travé, Josep
Berdún Peñato , Jesús
Borràs Pérez, Xavier
Bosch Coma, Imma
Burdoy, Emili
Burgaya, Miquel
Calderó, Domingo
Calvet Canaleta, M. Angels
Canalda, Xavier
Carles Contel, Joan
Caro, Sebastià
Carrera, Ion
Casadevall, Ricard
Castellano, Jaume
Colls Guerra, Cristina
Colls, Cristina
Cosialls Pueyo, DelfÍ
Cots Reguant, Francesc
Cucala i Rovira, Meritxell
Dalmau, Albert
Delmas, Gerard
Diaz, David

Diez, Alfonso
Dilmé Barón, Xavier
Domingo, Lidia
Domínguez Font, Carles
Escarrabill, Joan
Estruch Gay, Hartmann
Fàbregas Escurriola, Mireia
Fajardo, Joan Carles
Fina Avilés, Francesc
Font Ferrer, David
Fuentes, Antoni
Gabaldà Azofra, Jordi
Gallego Pérez, Carlos
García Asquerda, Daniel
García Cuyàs, Francesc
García Eroles , Luis
Garcia Mantas, Ascension
Garcia Mantas, Ascensión
García, Daniel
Garcia, Nuria
Giraldo, Priscila
Gonzalez Alonso, Pedro Javier
Gonzalez Boronat, Marc
Gonzàlez Mestre, Assumpció
Gonzalez, Núria
Grande, Luis
Guerrero Obis, Pere
Guiteras Mauri, Carme
Hernández Corbacho, Sara
Homs Obradors, Merce
Ibáñez, Rocío
Iglesias Rodal, Manuel
Izquierdo, Elisabet
Labordena Barcelo, Xus
Lejardi Estevez, Yolanda
Liarte, M José
Luchetti, Giannni
Lupiañez, Francisco
Maria Marín, Jose
Màrquez, Albert
Martí Aguasca, Tino
Martinez Cruz, Olga
Martinez Ferrer, Jan Guillem
Martinez Roldan, Jordi
Martínez, Manel
Martinez, Miquel Àngel
Masi Roig, Antoni
Medina Peralta, Manuel
Méndez , Cristina
Mias, Montse
Miralles, Felip
Moharra Frances, Montserrat
Molina, Cristina
Monterde, David
Moñino, Alex
Moya, Francesc
Muñoz Ortiz, Laura
Mussach, Paul
Narejos Pérez, Sílvia
Nozal Baldajos, Montserrat

Olivares, Marta
Oliveres, Francesc
Olmos Domínguez, Carmen
Orellana, Miguel Angel
Pages, Nuria
Paloma, Joan
Palou, Núria
Pascual, Julio
Pérez Sust, Pol
Pérez, Maribel
Pérez, Pepe
Piera Jiménez , Jordi
Pontes García, Cari
Pratdepadua Bufill, Carme
Puigdomenech Puig, Elisa
Pujol, Francesc
Reventós Gil de Biedma, Maria
Rius Soler, Ariadna
Roca, Daria
Roca, Xavier
Ródenas, Pepi
Rodriguez, Germán
Romeu, M Àngeles
Roser Cadena, Maria
Rubies Feijoo, Carles
Ruesga Fernández, Olga
Ruz, Fran
Sans Corrales, Mireia
Santaeugènia González, Sebastià
Sarle, Jordi
Saura Agel, Pilar
Serra, Consol
Singla, Xavi
Sitjas, Eric
Solà, Victor
Solans Fernández, Oscar
Torre, Pilar
Torrejon, Toni
Torrent, Ferran
Ureña, Montse
Uria, Joan
Valls, Jordi
Vela Vallespin, Emili
Velasco Muñoz, César
Vidal Alaball, Josep
Vila Ribas, Esther
Vilà Sans, Josep
Vilanova i Ballet, Anna
Vilar Mateo, Ruth
Vinue, Josep Mª

Guests invited to the Information Systems Master Plan participatory event

Adam, Paula
Alessandro, Rossana
Almazan, Cari
Amado, Ester
Amil Bujan, Paloma
Angles, Roser
Ansa, Xavier
Antoni Shonengerg, Joan
Arrebola, Xavier
Barrabeig, Irene
Benaque, Alba
Benavent Navarro, Anna
Benavent, Anna
Benet, Josep
Biescas, Herminia
Boixadera, Arcadi
Bonet, Anna
Borras, Xavier
Borruel i Llovera, Anna
Bosch Coma, Imma
Bullich, Ingrid
Burjons, Xavier
Bustins, Montse
Caminals, Alex
Carmona, Gloria
Carrasco, Marta
Casanovas, Cristina
Cid Colom, Jordi
Ciruela, Pilar
Coll, Dolors
Colls, Cristina
Conrad Casas,
Delmàs Camacho, Gerard
Diaz, Estela
Domenech, Montserrat
Escobar, Joaquim
Escoda Geli, Nuria
Escuriet, Ramon
Espallargues, Mireia
Estruch Gay, Hartmann
Falguera Puig, Gemma
Fernandez, Daniel
Figueras, Rosa
Fillat, Cristina
Fontecha, Benito
Franzi, Alicia
Freitas, Adriana
Freixedes, Rosa
Freixes, Meritxell
Gabaldà Azofra, Jordi
Gabernet, Marta
Gallego Pérez, Carles
Galvan, Leonardo
Garcia Cuyas, Francesc
Gil Prades, Montserrat
Gimenez, Emmanuel
Gonzalez Viana, Angelina
Guiteras Mauri, Carme
Gutierrez Coello, Mariano
Jimenez Leal, Rosario

Jose Liarte Gómez, Maria
Josep M.Giu,
Labordena Barceló, Xus
Labordena, Txus
Llauger, M Antonia
Lomas, Sandra
López, Pilar
M. Lalueza, Estrella
Marchal, Anna
Maria Melendo, Eva
Maria Picaza, Jose
Marrugat, Jaume
Martinez, Roser
Mas, Roser
Medina, Antonia
Medina, Manuel
Mirete Bara, Silvia
Molina, Amparo
Morales, Vicente
Mundet Sucarrats, Carles
Nieto Garcia, Nacho
Nolla Domenjó, Maria
Olivé, Marcel
Oms, Miriam
Pareja, Clara
Parellada, Joan
Piñeiro, Pilar
Piñol, Ramon
Prat, Alba
Puente, Anna
Puig Soler, Rita
Rado Trilla, Nuria
Ramos, Rafael
Reñe, Anna
Riba, Jordi
Ribalta, Alba
Ribas, Anna
Rios Jimenez, Anna
Roig, Marta
Roma Millan, Josep
Roqueta, Fermi
Rosello Calzada, Toni
Rubio, Anna
Ruiz, Rosa
Sagarra, Marta
Salvador Campasol Torra,
Schiaffino, Anna
Subirana, Pere
Teresa Romera,
Torres, Paco
Tresserras Gaju, Ricard
Troncoso, Amelia
Vallano, Antoni
Vaquero, Jesus
Vicente Balis, Montse
Vilà Sans, Josep
Vila, Esther

Interviewees

Andreu Périz, Antoni
Ara del Rey, Jordi
Argimón Pallàs, Josep Maria
Arrufat Vila, Miquel
Artigas Echevarria, Alex
Barberá Lluis, Albert
Benavent Navarro, Anna
Borrás Campabadal, Palmira
Borrás Pérez, Xavier
Bosch Coma, Imma
Bullich Marín, Ingrid
Casacampera Fernández, Gemma
Casanovas Lax, Joaquim
Casas Segalà, Conrad
Castillo Salinas, Félix
Colomer Mascaró, Jordi
Constante Beitia, Carles
Craywinckel Martí, Gemma
Cuervo Argudín, Jose Ignacio
Dedeu Baraldés, Antoni
del Castillo Rey, Manel
Elvira Martínez, David
Estany Ricart, Jaume
Font Ferrer, David
Fusté Sugrañes, Josep
Gabaldà Azofra, Jordi
García Eroles, Luís
García Asquerda, Daniel
García Cuyàs, Francesc
Gracia Escoriza, Rafael
Grueso Mula, Javier
Guanyabens Calvet, Joan
Ibáñez Pardos, Josep Lluís
Jorda- Sampietro, Esther
Juan Pastor, Antoni
Juvé Udina, Lala
Labordena Barceló, Xus
Lapena Estrella, Carolina
Lejardi Estévez, Yolanda
Lopez Calahorra, Pilar
Mangrinyà Rull, Pilar
Martí López, Joan
Martínez Ibáñez, Vicenç
Medina Peralta, Manuel
Molina Parrilla, Cristina
Monedero Boado, Jordi
Olmos Dominguez, Carmen
Pané Mena, Olga
Pareja Rosell, Clara
Pérez Sust, Pol
Piera Jiménez, Jordi
Planas Miret, Ivan
Pontes García, Caridad
Prat Pubill, Bibiana
Rams Pla, Neus
Robert Roca, Víctor
Ródenas León, Pepi
Ruiz Riera, Rafael
Sanchez Castro, Judit
Sanchez Ferrín, Pau

Santaeugènia González, Sebastià

Saura Agel, Pilar

Soley Bach, Pere

Vidal Fernández, David

Participating entities

AQuAS (Agència de Qualitat i Avaluació Sanitàries de Catalunya)

CatSalut

Consorci de Salut i Social de Catalunya

Departament de Salut

Fundació TicSalut Social

Institut Català de la Salut

Unió Catalana d'Hospitals

UNITSS (Associació Catalana de Professionals d'Informàtica de la Salut)

Glossary

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AP	Atenció Primària [primary care]
APDCAT	Agència de Protecció de Dades de Catalunya [data protection agency of Catalonia]
API	Interfícies d'aplicació [Application Programming Interface]
AQuAS	Agència de Qualitat i Avaluació Sanitàries de Catalunya [agency for health quality assurance and evaluation of Catalonia]
ARCO	Accés, Rectificació, Cancel·lació, Oposició [data subjects rights of access, rectification, cancellation, and opposition]
CATSALUT	Catalan Health Service
CDO	Chief Data Officer
CETIC	Comitè Estratègic de Responsables de les Tecnologies de la Informació i les Comunicacions [Strategic Committee of Chief Information Officers]
CIP	Codi d'Identificació Personal de salut [Catalonia health card]
CMBD	Conjunt Mínim Bàsic de Dades [minimum basic data set]
CSSC	Consorci de Salut i Social de Catalunya [social health consortium of Catalonia]
CTTI	Centre de Telecomunicacions i Tecnologies de la Informació [telecommunications and IT center]
CUAP	Centre d'Urgències d'Atenció Primària [urgent care center for primary care]
DCU	Disseny centrat en l'usuari [user-centered design]
DWH	Data Warehouse
ECAP	Estació Clínica d'Atenció Primària [Clinical Workstation for Primary Care]
ECG	Electrocardiografia [electrocardiography]
EHR	Electronic Health Record
EMR	Electronic Medical Record
ENAPISC	Estratègia Nacional d'Atenció Primària i Salut Comunitària [national strategy on community-based health and primary healthcare]
ETL	Extracció, Transformació i Càrrega [data extraction, transformation, and loading]
HC3	Història Clínica Compartida de Catalunya [shared health record of Catalonia]
HCE	Història Clínica Electrònica [electronic medical record]

HES	Historial Electrònic de Salut [electronic health record]
HIS	Hospital Information System
IA	Intel·ligència Artificial [Artificial Intelligence]
IaaS	Infrastructura com a servei [infrastructure as a service]
ICS	Institut Català de la Salut [Health Institute of Catalonia]
IoT	Internet de les coses [the Internet of Things]
IS3	Plataforma d'interoperabilitat [interoperability platform]
LMS	La Meva Salut [the citizen's personal health folder]
LOSC	Llei d'Ordenació Sanitària de Catalunya [law on the organization of healthcare in Catalonia]
OCEI	Oficina de Catàlegs i Estàndards d'Interoperabilitat [office of catalogues and standards for interoperability]
PCC	Pacient Crònic Complex [complex chronic patient]
PIIC	Pla d'Intervenció Individual Compartit [Individual healthcare intervention shared plan]
PREALT	Programa pre-alta hospitalària [hospital pre-discharge programme]
RCA	Registre Central d'Usuaris [central record of users]
RCDS	Repositori central de dades sanitàries [central repository of healthcare data]
RSA	Registres Sanitaris [health records]
SAD	Servei a Domicili [home care service]
SEIS	Sociedad Española de Informática Sanitaria [Spanish society of health informatics]
SEM	Servei d'Emergències Mèdiques [medical emergency service]
SIMDECAT	Sistema de digitalització de la imatge mèdica [medical image digitalization system]
SISCAT	Sistema integrat d'utilització pública de Catalunya [Integrated Public Healthcare System of Catalonia]
TAC	Tomografia axial computeritzada [computed tomography]
TI	Tecnologies de la informació [information technology]
TIC	Tecnologies de la informació i la comunicació [information and communication technologies]
UCH	Unió Catalana d'Hospitals [union of Catalan hospitals]
XAP	Xarxes d'Atenció Primària [primary healthcare networks]