Costa Rica's Unified Digital Health Record (EDUS) System: Best Practices, History, and Implementation

DIGITAL HEALTH CASE STUDIES

CASE STUDY 6

Acknowledgments: The IDB team would like to thank everyone who participated in interviews and provided key information for this case study.

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CONTENTS

ABBREVIATIONS & ACRONYMS

EDUS	*Expediente Digital Único en Salud* (Unified Digital Health Record)
CCSS	*Caja Costarricense del Seguro Social de Costa Rica* (Costa Rican Social Security System)
PASS	*Proyecto de Automatización de Servicios de Salud* (Health Services Automation Project)
MINSA	*Ministerio de Salud Pública de Costa Rica* (Ministry of Public Health of Costa Rica)
EBAIS	*Equipos Básicos de Atención Integral en Salud* (Basic Integral Healthcare Teams)
INS	*Instituto Nacional de Seguros de Costa Rica* (National Insurance Institute of Costa Rica)
CGR	*Contraloría General de la República de Costa Rica* (Office of the Comptroller General of the Republic of Costa Rica)
ICE	*Instituto Costarricense de Electricidad* (Costa Rican Electricity Institute)
RACSA	Radiográfica Costarricense S.A.
SNI	*Sistema Nacional de Información de la CCSS* (National Social Security Information System)
SINIRUBE	*Registro Único de Beneficiarios del Estado* (Unified Registry of Government Beneficiaries)
UNM	*Unión Médica Nacional* (National Medical Union)
SINAME	*Sindicato de Médicos Especializados* (Union of Medical Specialists)
TSE	*Tribunal Supremo de Elecciones de Costa Rica* (Supreme Electoral Court of Costa Rica)
MICITT	*Ministerio de Ciencia, Innovación, Tecnología y Telecomunicaciones* (Ministry of Science, Innovation, Technology, and Telecommunications)

EXECUTIVE SUMMARY

Costa Rica embarked on the Unified Digital Health Record (EDUS) project in 2010 to organize all medical and social security information of Costa Rican Social Security System (CCSS) enrollees in a single digitalized file system.

This case study explains what the EDUS is, how it works, the challenges it faced, and the benefits it has produced.

It also offers best practices for designing, developing, and implementing electronic health records. Additionally, it addresses two recent episodes in the history of Costa Rica's EDUS: how it dealt with the COVID-19 pandemic, and the cyberattacks the country experienced in 2022, which shut down the EDUS service for two months.

To prepare this case study, the authors reviewed laws, minutes, CCSS reports, and prior studies on the EDUS. They also interviewed ten former and current CCSS employees and organized two discussion groups, one with CCSS staff from different regions and another with users.

The EDUS did not come into being overnight. Costa Rica has been taking steps since 1990 to automate and digitize healthcare services. Its first attempts were disjointed and did not encompass all levels of Costa Rica's institutional framework for public health.

From 2010 onward, various factors converged to breathe new life into the initiative, and the country began implementing the EDUS as a nationwide project that was rolled out gradually in stages between 2013 and 2018.

During this period, the main challenges were related to technological infrastructure, human resources, regulations, communications, and financing. The project also encountered resistance rooted in technological and generational gaps, fear of technology, entrenched practices and habits, concerns about institutional control over staff, and questions about the IT systems' stability.

To overcome these challenges and points of resistance, the project used the change management methodology to involve the various stakeholders. This strategy consists of identifying leaders and engaging them in the process, as well as creating change management networks and communication plans for each health center, clinic, or hospital. As part of the strategy, the project organized peer-to-peer training and spoke with users to collect their requests.

Evidence based on healthcare professionals' perceptions shows that once the EDUS began operating, it streamlined healthcare processes, helped medical appointments stay on schedule, improved the quality of information available for decision-making, standardized procedures, boosted the productivity of CCSS staff, strengthened predictive analysis capacity, and narrowed the digital gap between healthcare centers. Meanwhile, the EDUS mobile app has gained traction as a tool for improving healthcare service delivery and guaranteeing access to medical information.

During the pandemic, the EDUS allowed Costa Rica to systematize information about hospital and hospital bed occupancy rates. It also provided access to information on each patient from any medical center, decreased trips to healthcare centers and therefore exposure to the virus, and provided mobile access to up-to-date information like lab results, diagnoses, and appointments, keeping people from having to go to healthcare centers in person.

In 2022, there were cyberattacks on nearly 30 government agencies in Costa Rica. While the EDUS's data was not hacked and no personal data was ultimately stolen or altered, the attacks did obstruct healthcare and lead to canceled medical procedures, confusion, and long lines at hospitals. During the event, the EDUS's historic achievement of centralizing healthcare information and making it traceable was temporarily reversed. The cyberattack has made CCSS staff much more aware of the need for an alternative contingency system to guarantee the continuity of technological and non-technological healthcare services.

Having made it through the pandemic and cyberattacks, the EDUS is now seen as a successful project and sets an example of how to digitally transform health systems. Future challenges include the potential use of artificial intelligence, private sector participation, using the system's information for predictive medicine, and strengthening communication with users

CASE STUDY INTERVIEWEES

Name	Role
Marielos Alfaro Murillo	Former legislative deputy and former member of the CCSS Borad of Directors. Interviewed on June 28, 2022 by Luisa Ochoa-Chaves.
Lucía Arias Durán	Coordinator of the change management component during the EDUS implementation process. Interviewed by Fernando Martínez de Lemos on June 13, 2022.
Guiselle Barrantes Brenes	Collaborator on the clinical component of the EDUS. Interviewed by Luisa Ochoa-Chaves on June 17, 2022.
Gabriela Murillo Jenkins	Former CCSS Head of Infrastructure and Technology. Interviewed by Óscar Jiménez-Alvarado on July 7, 2022.
Manuel Rodríguez Arce	Director of the EDUS project. Interviewed by Luisa Ochoa-Chaves on July 21, 2022.
Eduardo Rodríguez Cubillo	Coordinator of the clinical component of the EDUS. Interviewed by Fernando Martínez de Lemos on June 14, 2022.
María del Rocío Sáenz Madrigal	Former Executive President of the CCSS. Interviewed by Luisa Ochoa-Chaves on June 14, 2022.
Román Macaya Hayes	Former Executive President of the CCSS. Interviewed by Óscar Jiménez Alvarado on June 14, 2022.
María Isabel Solís Ramírez	Head of the Communication and Cultural Heritage Department of the Organizational Communication Directorate of the CCSS from January 2006 to January 2020. Interviewed by Fernando Martínez de Lemos on June 13, 2022.

1. INTRODUCTION

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The Unified Digital Health Record (EDUS) project consists of is a set of information systems that are integrated based on healthcare process's design in order to support the administrative and health needs of both patients and the institution.

It contains retrospective, concurrent, and prospective information, and its main purpose is to provide continuous, efficient, high-quality, and reliable support to the healthcare services of the Costa Rican Social Security System.

The EDUS provides a simple way to record the various health services that people need. It helps professionals diagnose and treat diseases, compiles the characteristics of each person and their families, and makes everything that happens in the Costa Rican health system traceable.

This case study explains what the EDUS is and how it works within Costa Rica's health system. It also describes the system's benefits and its potential challenges in upcoming years.

Additionally, this study systematizes the project's actions under its change strategy and lays out a list of good practices for designing, developing, and implementing unified electronic health records in other countries.

This case study also explores two recent episodes that impacted the EDUS in Costa Rica. First, it describes how the EDUS helped the health system navigate the COVID-19 pandemic, from the perspective of users and CCSS professionals. It then lays out the lessons learned from the cyberattacks on CCSS information systems, including the EDUS, that occurred on May 31, 2022.

The sources for this case study are:

1. **A document review of laws,** CCSS reports, and prior studies about the EDUS.
2. **Information from ten interviews** with current and former CCSS employees.
3. **Information from two focus groups,** one with CCSS staff from different regions of the country—in which thirteen people participated—and another with users from all over the country, whose contact information was provided by the CCSS team.

2. THE COSTA RICAN HEALTH SYSTEM AND THE EDUS

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» **In Costa Rica, health is considered a human right.**

Even though the country's constitution does not specifically establish health as a right, the Constitutional Chamber of its Supreme Court has granted it that status. In the opinion of this specialized court, the right to life established in Article 21 of Costa Rica's constitution encompasses health. The court finds an irrefutable connection between the two rights, since it is impossible to conceive of life without basic conditions of psychological, physical, and environmental balance.[3]

The same court has also upheld the right to health on the basis of Article 46, which establishes the right of consumers and service users to have their health protected; on the basis of Article 50, which establishes the right to a healthy environment; and on the basis of Article 73, which creates the country's social insurance schemes to protect workers from the risks inherent to diseases, disabilities, maternity, old age, and death. These precepts, as well as other supranational ones in conventions and treaties that Costa Rica has signed, form the foundation of the country's notion of health.

The Costa Rican health system is regulated by the General Health Law.[4] This law establishes that health is a public good protected by the state, which has the essential job of protecting the health of the entire population.

The Ministry of Health (MINSA) is the highest authority for health matters and is responsible for setting the national health policy and creating guidelines and measures for training, planning, and coordinating all health-related affairs in both the public and private sector.

The health system is primarily funded by the government under the principle of solidarity and universal coverage, although there are other types of financing, such as direct household or out-of-pocket spending and private insurance.

The government-run Costa Rican Social Security System (CCSS) is the country's largest and most important manager and provider of public healthcare services. According to the Constitution[2, 3, 4] and the law creating the system,[5] this autonomous institution is responsible for managing and providing health care services nationwide, as well as managing the Costa Rican social security system. The system is funded by resources from the different compulsory social security schemes. Other providers—whether public, mixed, or private—have been gaining ground in the market (Fernandez, 2018), but they have not yet attained the weight that the CCSS has within the Costa Rican health system.

Data from the National Institute of Statistics and Censuses shows that in 2022, 86.7% of the population was insured through the CCSS. The remaining 13.30% had private or foreign insurance.[6] This group can also use the CCSS's emergency services and then pay the institution.

[2] Decision No. 01915 of the Constitutional Chamber of the Supreme Court of Justice. (July 22, 1992). vLex. https://vlex.co.cr/vid/-497198930.

[3] The General Health Law (Law No. 5395) was passed on October 30, 1973. Since then, it has had 16 different amendments or changes of varying scope and type.

[4] Article 73, *Political Constitution of the Republic of Costa Rica*, 1949.

[5] Costa Rican Social Security System Law. (1949). Vol. 17. https://www.ilo.org/dyn/travail/docs/875/Ley constitutiva de la caja costarricense de seguro social.pdf.

[6] Costa Rica National Household Survey of July 2022 (INEC, 2022). Demographic characteristics of the population and access to social security by planning area and region.

People with access to public health services can also use private practitioners by purchasing optional insurance or paying out-of-pocket for a medical service at a private clinic or hospital.

The National Insurance Institute (INS), another government enterprise, offers a variety of insurance and services within Costa Rica and beyond its borders. It also manages the funds of the Occupational Hazards and Compulsory Vehicle Insurance systems. The INS is also public healthcare service provider, specifically covering work-related diseases or accidents or traffic accidents through the Trauma Hospital and facilities for addressing these health problems throughout the country.[7]

The country also has providers that function as public-private partnerships. These providers are healthcare centers run by associations or cooperatives that sign a management agreement with the CCSS. Based on CCSS data from December 2021, ten of the 105 healthcare areas use this scheme.[8] This means that 31 of the 529 Basic Integral Healthcare Team (EBAIS) offices in the country are run under a public-private partnership.

The CCSS's level of autonomy among government institutions is unique because it is explicitly granted by the country's constitution. In terms of organization, the Board of Directors is the CCSS's highest authority and is responsible for setting its strategic direction and making decisions. The board is led by the executive president of the CCSS, who is appointed by the president of Costa Rica and ratified by the Cabinet. Board members include two representatives from the executive branch, three from the private sector, and three from unions.[9]

The CCSS is operated and administrated by seven management units:

1. **General Management Unit**
2. **Administrative Management Unit**
3. **Infrastructure and Technology Management Unit**
4. **Financial Management Unit**
5. **Logistics Management Unit**
6. **Medical Management Unit**
7. **Pension Management Unit**

These units run the institution and must adhere to the decisions of the Board of Directors. The Administrative Management Unit is currently responsible for the EDUS, under the Innovation and Digital Health Component of the Information and Communications Technologies Directorate.

The CCSS provides its health services through a number of facilities. The facilities are organized into three levels of care and are interlinked vertically or horizontally to meet the needs of the entire population.

The levels are defined by response capacity, healthcare services offered, degree of complexity, technological capability, and human resources. Primary care is the least complex level. It serves as a gateway into the system and consists of the most basic or elemental healthcare. The secondary and tertiary levels provide more specialized and complex services. As explained below, the EDUS was first implemented to meet primary care needs.

[7] Ministry of Health of Costa Rica, 2022, 12.

[8] CCSS, 2022, 2.

[9] Article 6 of the Costa Rican Social Security System Law (Law No. 17, 1949) lays out how the Board of Directors is organized and the rules for electing sectoral and executive branch representatives.

The primary level encompasses the offices of the EBAIS, which are primary care units made up of professionals with a variety of backgrounds. Each team consists of a general practitioner, a nursing assistant, a primary care technical assistant, and a network assistant. These teams may or may not have a physical office, or several teams may work in the same facility. For this reason, the number of teams differs from the number of offices.

The primary care level also includes some CCSS health areas, which are the CCSS's smallest administrative units and which manage healthcare services for a specific, geographically defined population. These units are made up of administrative staff who manage budget and budget allocation, logistics, system enrollment, and other matters. To an extent, the health areas are the CCSS's administrative arm. Of the country's 105 health areas, 89 are considered part of the primary care level, while 16 belong to the secondary level, as shown in Table 1.

The secondary and tertiary levels include 6 specialized national hospitals, 3 general hospitals, 8 regional hospitals, and 12 peripheral hospitals that offer different services and degrees of specialization.[10, 11]

The CCSS's structure, its distribution in Costa Rica, and how it operates are relevant because CCSS is the institution in charge of designing, developing, and implementing the EDUS.

TABLE 1:
CCSS healthcare facilities: level of care and quantity (1 of 2)

Levels	Category	Quantity	Hospitals and additional information
Level 1	EBAIS	1,080	These facilities are located throughout the country according to the CCSS's regional distribution model.
	Periodically staffed posts	647	
	EBAIS offices	529	
	Health Areas	89	
Level 2	Health Areas	16	Some health areas are located in health clinics that also provide healthcare.
	Regional hospitals	8	Maximiliano Peralta (Cartago), Dr. Tony Facio (Limón), San Rafael (Alajuela), San Vicente de Paúl (Heredia), Dr. Enrique Baltodano (Liberia), Monseñor Víctor Manuel Sanabria (Puntarenas), Hospital de San Carlos, Dr. Fernando Escalante (Pérez Zeledón).
	Peripheral hospitals	12	William Allen (Turrialba), de Guápiles, Dr. Carlos Valverde (San Ramón), La Anexión (Nicoya), Ciudad Neilly, San Francisco de Asís (Grecia), de San Vito, de Upala, Dr. Max Terán (Quepos), de Los Chiles, Manuel Mora (Golfito), Tomás Casas (Osa).

[10] Caja Costarricense Seguro Social, 2021, 48-50.

[11] This includes periodically staffed posts that are currently receiving staff and those reported to have temporarily suspended visits due to the COVID-19 pandemic.

TABLE 1:
CCSS healthcare facilities: level of care and quantity (2 of 2)

Levels	Category	Quantity	Hospitals and additional information
Level 3	Specialized hospitals	6	Centro Nacional de Rehabilitación Dr. Humberto Araya Rojas, Hospital de Geriatría y Gerontología Dr. Raúl Blanco Cervantes, Hospital de las Mujeres Dr. Adolfo Carit, Hospital de Niños, Hospital Psiquiátrico Manuel Antonio Chapuí y Torres, Hospital Nacional Psiquiátrico Dr. Roberto Chacón Paut.
	General hospitals	3	Hospital Dr. Rafael Ángel Calderón Guardia, Hospital México, Hospital San Juan de Dios.

Source: Macaya-Hayes, 2022 and Memoria Institucional 2021 de la CCSS.

3. THE EDUS: A CCSS PROJECT. ARCHITECTURE AND DEVELOPMENT

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The EDUS is a CCSS project managed by the institution's Infrastructure and Technology Management Unit. Its implementation is carried out a both a strategic level and operational level (Cabello Cano, 2020).

At the strategic level, the EDUS is managed by the CCSS's main decision-making bodies (the Board of Directors and the Office of the Executive President), which signals the political importance given to the project. The Board and the Office of the Executives President handle the institutional and financial management aspects, make managerial decisions, and administer the project's resources.

At the operational level, the Management Committee is responsible for setting courses of action and monitoring the project's implementation, transition, and integration phases, as well as actively participating in decision-making. The Infrastructure and Technology Management Unit and the Medical Management Unit, which are directly in charge of the project, participate as part of this committee.

The Management Committee is structured as follows: When an EDUS component is to be added, a Clinical Management Integration Committee first establishes an overarching vision and clinical focus. Subsequently, the Health Statistics Division[12] is added to the team.

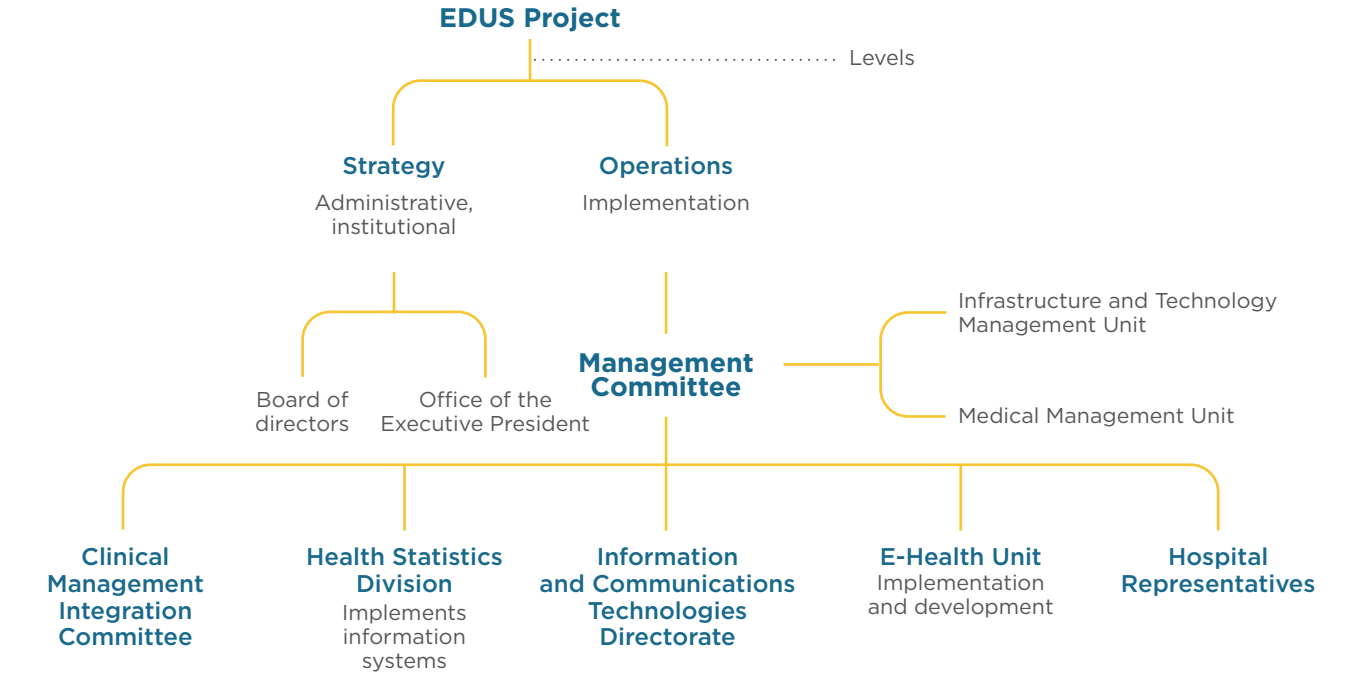
This division is responsible for implementing the system for routine activities, monitoring regulatory and clinical management and running the information systems. The Information and Communication Technologies Directorate is also incorporated at this time. This directorate includes the CCSS's E-health Unit, which is responsible for implementing and running the EDUS. This unit, with 125 members who work exclusively on the EDUS, is tasked with ensuring that the system actually achieves its objectives and with managing the logistical and administrative aspects of the project.

The organizational scheme shown in Figure 1 has been very important to the success of the EDUS, as it has resulted in harmonious internal governance of the project (Murillo-Jenkins, 2022).

The EDUS team is multidisciplinary: It includes people with backgrounds in medicine, nursing, laboratory, and other health sciences. It also involves professionals from other disciplines like engineering, statistics, and project management. On this diverse team, the clinical component is given priority and is considered the "heart of the EDUS" (Arias Durán, personal correspondence, 2022), so professionals in medicine, nursing and specialties have had a hand in designing and developing the various systems that make up the unified digital record. In addition, the EDUS spans the different levels of the CCSS and has various work teams that participate on a part-time or full-time basis.

[12] The Health Statistics Division and the Health Services Development Directorate were added to the process to "review the parameters of care included in the SIES and prioritize the inclusion of missing forms to avoid redundancies in file management." Social services audit area, 2016.

FIGURE 1:
CCSS organizational structure for implementing the EDUS project



Source: Prepared by the authors.

The EDUS was developed in-house by the CCSS itself. The CCSS decided to create the system in-house for the reasons described below (Rodriguez Arce, personal communication, 202).

1. **The CCSS's experience in developing its own technology.** Before implementing the EDUS in 2012, the CCSS had already been developing its own software, primarily for scheduling appointments, as well as the family record system. These projects had been carried out by CCSS employees, although in some cases third parties were hired, but without compromising source code availability and access.

2. **External proposals that did not meet the CCSS's needs.** Although the CCSS did request some estimates and quotes from service providers, the proposals it received did not fully meet the complex needs of an institution like the CCSS, which emphasizes primary care.

3. **In-house development and customizing the system to the CCSS's needs.** An in-house process enabled the CCSS the tailor the system to its requirements and subsequently modify and expand it by adding other systems. Having the EDUS source code allowed "the CCSS to own our license and have full control over the record system's future" (Rodríguez Arce, personal correspondence, 2022).

4. **The well-established software development team at the Information Technology Department.** "We are capable of handling any change that is needed, we do not depend on anyone else, and our costs are limited to those related to normal salaries" (Rodríguez Arce, personal correspondence, 2022).

5. ***"We'll make the DNA ourselves."***[13] The CCSS has a culture of developing products, including medications and technology, in-house. From this perspective, *"the biggest mistake*

[13] Alfaro Murillo, personal correspondence, 2022.

one could make is to hand over development and have a third party come and tell us what we need" (Alfaro Murillo, personal correspondence, 2022). The CCSS is therefore in the best position to design the system because it has thorough knowledge not only of the healthcare system and the country's idiosyncrasies, but also of the target population and political and economic priorities.

From a software perspective, the EDUS consists of several systems, as shown in Table 2.

TABLE 2:
Systems comprising the EDUS: functionalities and users (1 of 2)

System	Description	Number of users*
SIES	**Integrated Health Record System:** This system supports administrative and clinical management of patient care; presents clinical information for diagnosing and treating diseases; and automates the pre-appointment, appointment, and post appointment processes. It is used by authorized health personnel, who record the activities generated for each user at the different CCSS health centers. The SIES provides a swift, complete, and simple way to record and follow up on healthcare processes in general outpatient, specialized outpatient, emergency, and hospitalization services.	31,947
SIAC	**Integrated System for Enrollment, Scheduling, and Appointments:** This system automates and standardizes user service processes. It allows the CCSS to keep record of and validate the rights of insured people; identify and compile information on the population served; manage medical scheduling (outpatient or general appointments) and disabilities; and print labels, receipts, and other documents.	11,529
ARCA	**Hospital admission/discharge module:** This module manages data related to patient hospitalization processes. **Surgical module:** This system manages administrative data on surgeries and hospitalization.	7,577
SIFF	**Integrated Family Record System:** The family record links a person to a family or household through a geo-referenced registry that allows the CCSS to keep track of its activities (for example, accessing health promotion materials); know the housing, health and environmental conditions of each family; and support the home visits carried out by the ATAP and planning for primary care activities.	2,948
Pathology	**This system supports and automates the management of anatomical pathology services** at the hospitala level and makes it easier to trace biopsy, cytology, and autopsy samples.	1,881
SIVA	**Integrated Vaccination System:** This tool automates and standardizes patients' immunization records. Authorized health personnel enter vaccines, as well as all tasks related to immunization at the different CCSS health centers.	1,197
SILC	**Integrated Clinical Laboratory System:** This system manages lab requests and results.	551
SIVE	**Integrated Epidemiological Surveillance System.**	261

TABLE 2:
Systems comprising the EDUS: functionalities and users (2 of 2)

System	Description	Number of users*
SICI	**Integrated Cytology System:** This system automates and standardizes the diagnosis of cytology samples that are analyzed at the National Cytology Center. Authorized health personnel use the system to enter requests for cytology analysis from patients at the CCSS's different health facilities. The staff of the National Cytology Center can then perform the different activities related to diagnosing those samples.	63
SIFA	**Integrated Pharmacy System:** This system manages data related to delivering medicines to patients.	3
SIUR	**Emergency Department Integration System:** This system handles emergency room admittance forms.	**
MISE	**Integrated Security Module:** This module's purpose is to support control and integrated management of the cybersecurity mechanisms of the different CCSS systems. The MISE is an independent system that serves to centralize the CCSS cybersecurity scheme for the information systems that need that centralization. Its functionalities include managing users, access levels, and restrictions; recording, maintaining, and debugging logs; and managing access levels and permissions. It also has system configuration and report generation functions.	**
Reports	**Administration dashboard** for exporting statistical data.	**

Note: Prepared by the authors based on the following references: (Cabello Cano, 2020). The systems are listed from largest number of users to smallest. * Data provided by the EDUS development team, from the Integrated Security Module (MISE). Users may have accounts in one or more systems and/or modules. ** No data available.

Most of these systems are used exclusively by CCSS staff to manage the health records of each Costa Rican public health service user.

Although the systems operate independently and with their own user roles, they are integrated through a shared, centralized, on-premise database[5] with redundant backup. In other words, the information is backed up on the CCSS's local servers and devices, giving the CCSS physical access and direct control over the configuration, management, and security of this data. The files are copied to at least two locations simultaneously to boost the system's reliability and make it failsafe.

The various systems and modules are developed in the JAVA programming language.[14, 15]

During the development process, the EDUS team held consultation sessions with CCSS staff. Staff from nursing, medicine, pharmacy and other specialties took part in developing the EDUS, using the change management methodology described later on in this case study. There is no record of participation by external stakeholders, but some people on the EDUS development team researched electronic health record experiences in other countries.

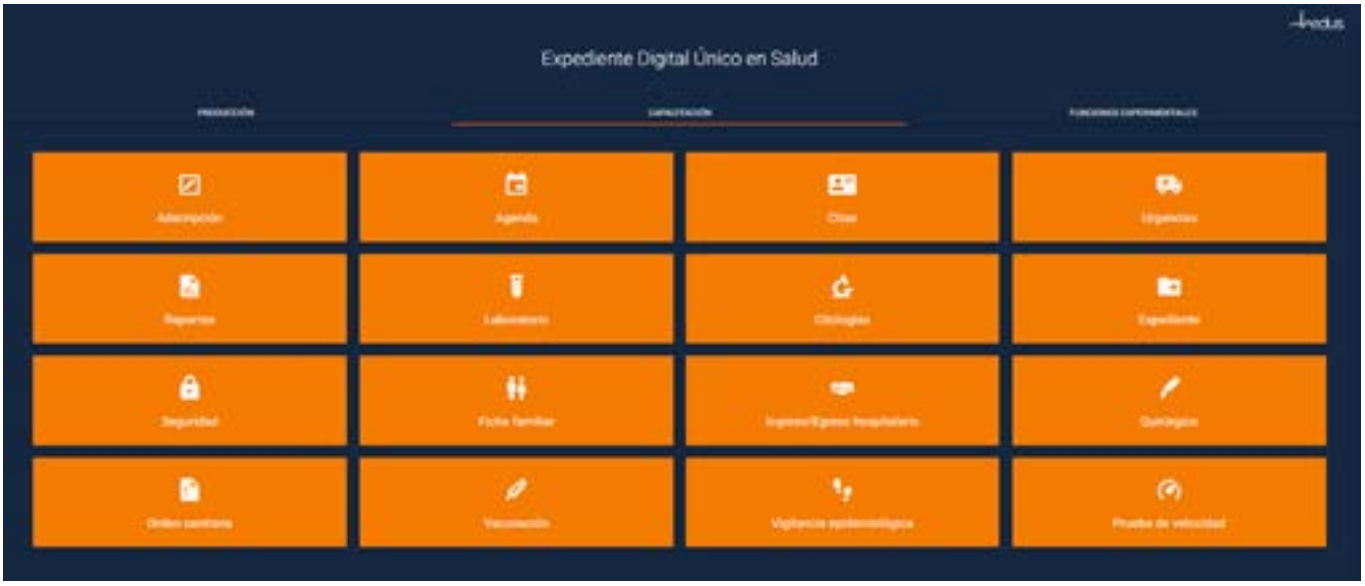
[14] An on-premise database means that the software and data are stored on local CCSS servers and devices.

[15] Java is a computer programming language platform created in 1995 by American technology company Sun Microsystems. Specific technical training is required to develop software using this programming language.

As different people and specialties were included in the process of designing the EDUS, it became clear that the information to be included in the system for each medical area needed to be standardized, bridging the differences between hospitals and health facilities and following the CCSS's regulations (Rodríguez Cubillo, personal correspondence, 2022). This meant eliminating or assimilating hospital-specific software systems, as well as replacing hospital-specific forms for keeping records.

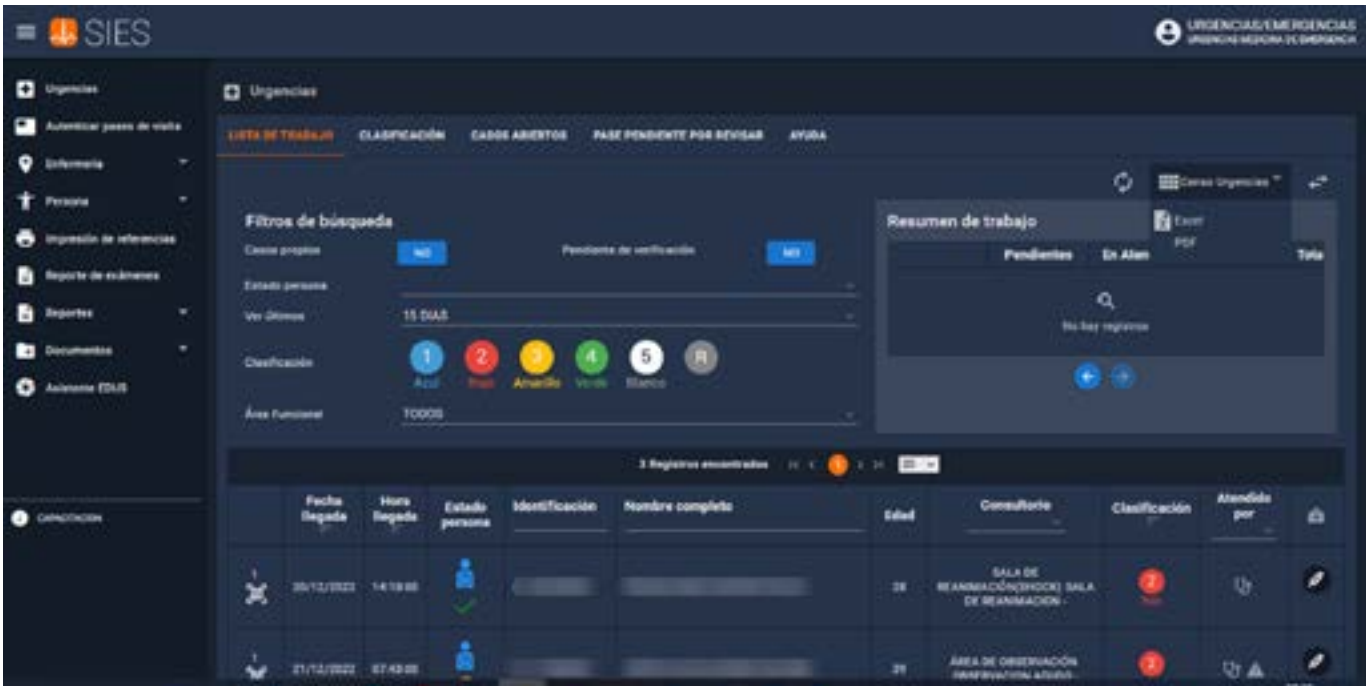
The minimum data set needed in order to open a digital record includes demographic information (full name, identification, place of residence, among others), a healthcare action associated with the person (outpatient, emergency, or hospitalization), and a diagnosis (Cabello Cano, 2020).

FIGURE 2:
Screenshot of the EDUS and its systems



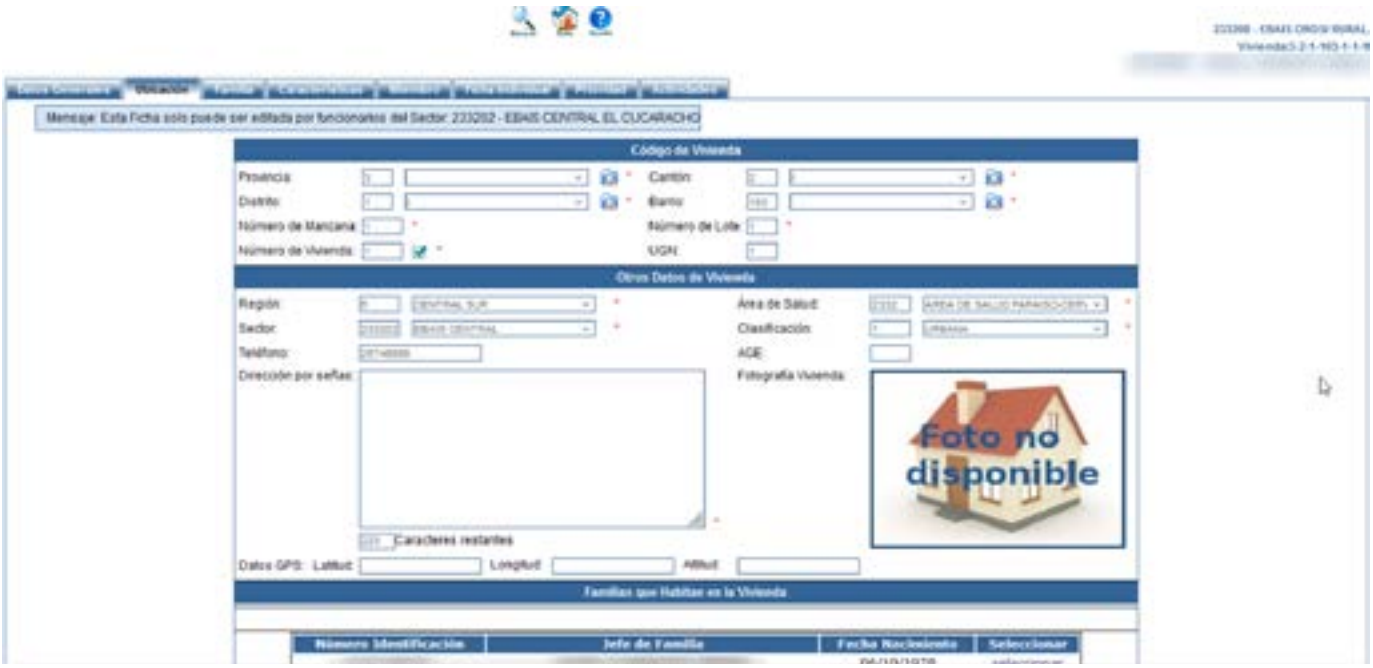
Source: Image provided by the EDUS development team.

FIGURE 3:
Screenshot of the SIES system of the EDUS



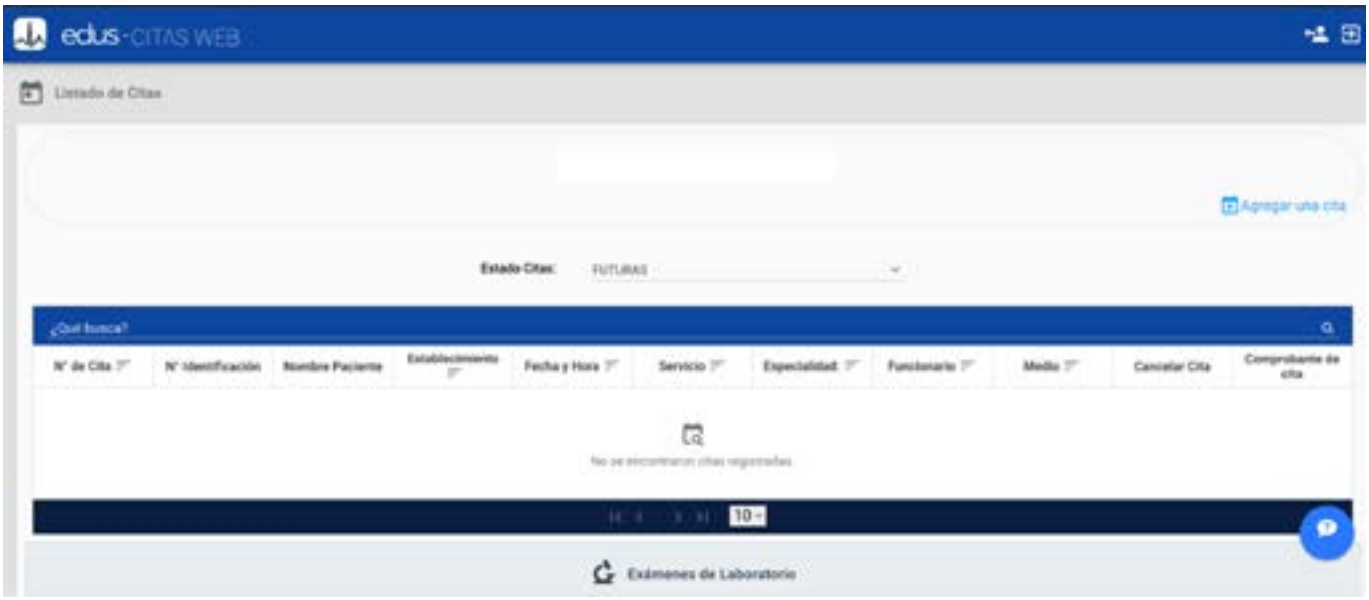
Source: Image provided by the EDUS development team.

FIGURE 4:
Screenshot of the SIFF system of the EDUS



Source: Image provided by the EDUS development team.

FIGURE 5:
EDUS webpage where users can request appointments



Source: Screenshot from https://edus.ccss.sa.cr/eduscitasweb/, January 20, 2023.

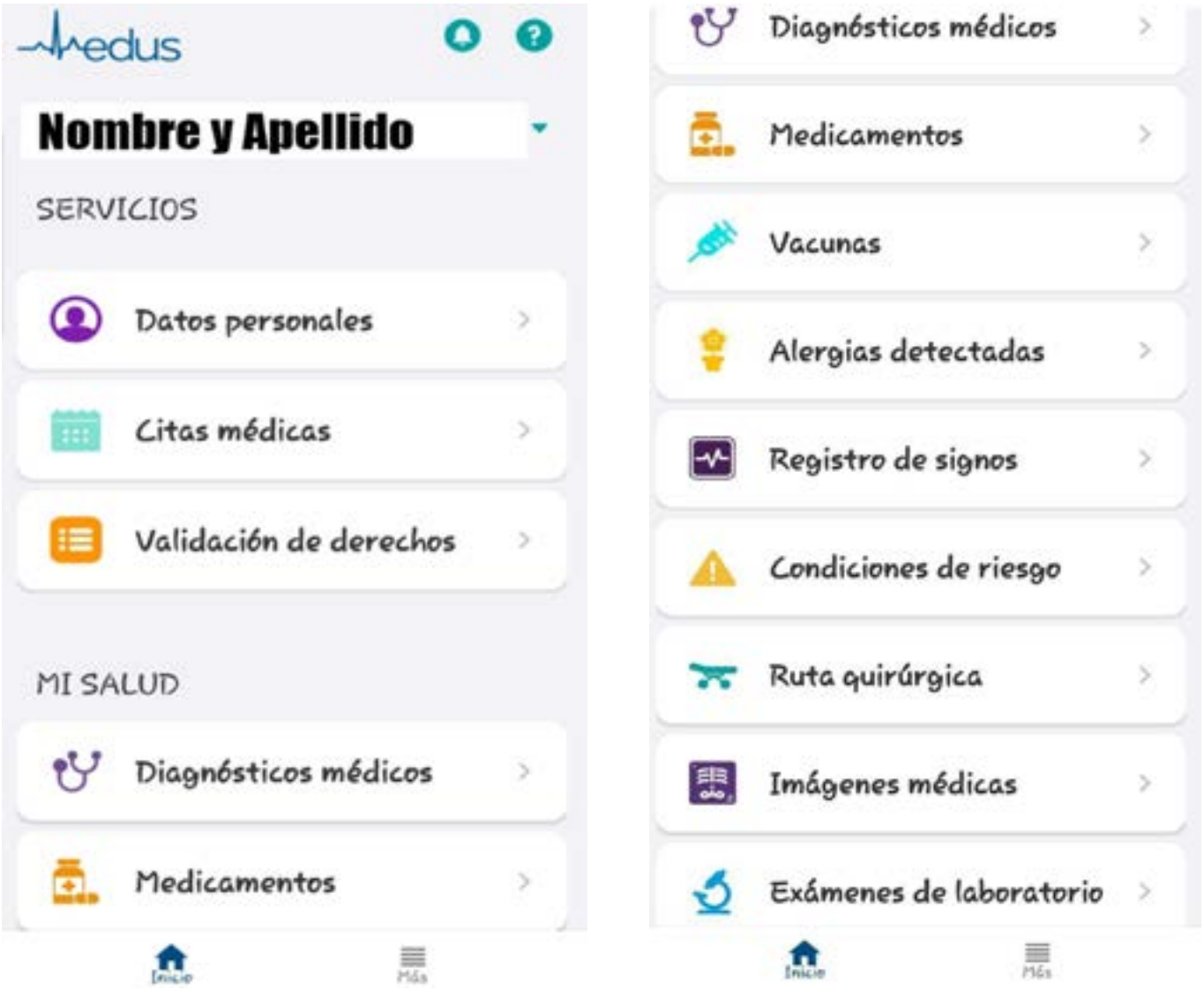
While there is an active web platform for the EDUS (https://edus.ccss.sa.cr/eduscitasweb/), only some appointments offered by health facilities can be requested on it. All other appointments have to be requested in person at the facilities.

The EDUS has also offered a mobile application since 2015. From the app, users can access: personal data, medical appointments, validation of rights, medical diagnoses, medications, vaccinations, allergies detected, vital signs, conditions under which vital signs were taken, surgical records, medical images, and laboratory tests.

The analysis of how end users or patients connect with the CCSS through the EDUS clearly shows the CCSS's commitment to developing the mobile application (https://www.ccss.sa.cr/appedus). The app's benefits (portability, mobility, and greater access)[16] boost its popularity, and it has been downloaded 5,560,000 times since March 2018 and remains the top health app in the iOS and Android stores in Costa Rica (Macaya-Hayes, 2022).

[16] Costa Rica has a high mobile connection penetration rate. As of January 2021, there were 8.93 million mobile connections, equivalent to 174.4% of the total population. The number of mobile connections rose by 383,000 (4.5%) from January 2020 to January 2021. The speed of mobile Internet connections is 20.02 MBPS, with year-on-year increases of 5.6% (Kemp, 2020). 76% of mobile connections are between the 3G (95% of the country has 3G coverage) and 5G bands. The penetration rate of mobile broadband connections is 131%. GSMA 2020:

FIGURE 6:
Image of the EDUS mobile app for end users



Source: Screenshot of the EDUS app, January 20, 2023.

4. HISTORY AND IMPLEMENTATION OF THE EDUS

4. HISTORY AND IMPLEMENTATION OF THE EDUS

The EDUS was implemented and became well established within the public health system as a result of a long and complex process spanning several decades, during which Costa Rica promoted medical informatics and various initiatives to automate healthcare services. This section summarizes that development process, providing historical background and describing the main implementation milestones.

4.1. Historical background

The CCSS's use of technology dates back to the late 1960s, when the institution bought equipment to mechanize payroll processes, accounting programs, and storage facilities (Alvarado *et al.*, 2007). According to the CCSS's Institutional Information System (2012), over the next decades the CCSS rolled out software for other financial and operational areas but did not implement solutions for clinical and healthcare management.

In the 1990s, the CCSS became more serious about developing health information systems (Amamor-Zamora and Salas-Montero, 2019) and created the Medical Informatics Department to automate primary care data. Information management became fragmented for the first time during this period, due to several standalone initiatives and the fact that some health centers bought software subsystems from different suppliers that used a variety of platforms and programming languages.

In 2002, CCSS's began working to end to this segmentation of IT systems. In June of that year, the Board of Directors instructed the Information Technology Unit to automate and reorganize the CCSS's institutional information system. As a result, the Health Services Automation Project (PASS) was created on January 30, 2003. This project was the EDUS's main precursor.[17]

The PASS aimed to solve the operational problems of the health services and information system through a platform that was integrated according to the CCSS's needs and expectations (Amador-Zamora and Salas-Montero, 2019). The intention was to also use it to automate pharmacy and laboratory services, improve services for users, and launch a prototype of an electronic health record.

The project achieved several successes. For example, it automated outpatient and hospital care processes, as well as clinical, technical, and administrative support services (Cabello Cano, 2020). It also set in motion a pilot plan to improve care at six clinics.[18] However, in general it did not meet its goals or create an integrated electronic record.

Two key considerations partially explain the lack of progress on the electronic record component. First, the CCSS had planned to outsource the project, but this plan hinged on a World Bank loan that was not approved. Second, when the loan failed to come through, the CCSS attempted to reach an agreement with the National Insurance Institute (INS) to use its Administrative Medical Information System (*Sistema de Información Médico Administrativo*),[19] but in 2003 the Office of the Comptroller General of the Republic (CGR) eliminated this option, arguing that the impact it would have on achieving the PASS's objectives had not been properly studied.

[17] Article 5 of Session 7724 of the Board of Directors of the CCSS.

[18] According to the pre-feasibility study, the pilot plan was implemented at the Marcial Fallas, Carlos Durán, Clorito Picado, Solón Núñez, Central, and Moreno Cañas clinics.

[19] La Nación. (September 26, 2003). "Caja probará expediente médico del INS".

Following these two failed attempts, the issue remained on standby until 2006, when the CCSS circled back to the idea of creating an electronic record.

Although work to develop today's iteration of the EDUS began in 2013, the concept first appeared in 2008, with the creation of a very general project (Amador-Zamora y Salas-Montero, 2019) to automate appointments, schedules, clinical laboratory information, blood banks, and family information systems (Cabello Cano, 2020).

From 2008 to 2010, other preliminary initiatives emerged, but they also suffered from a lack of centralized institutional coordination. For example, during this time the Hospital San Vicente de Paul in Heredia and the Hospital de Niños implemented their own electronic record systems (Diaz, 2010). But these systems were not interconnected with each other or with other levels of healthcare, leading to an undesirable segmentation of users.

Around the same time, the Council of Notables formed by President Laura Chinchilla to analyze the CCSS's situation recommended that an electronic record system be declared *"(...) an institutional priority, with a clear deadline for implementation nationwide and at all three levels of healthcare" (Sauma Fiatt et al., 2011)* (Sauma Fiatt *et al.*, 2011). The same council described it as "unacceptable" not to have this application yet (Sauma Fiatt *et al.*, 2011).

» **In this context, there were three key events related to the EDUS that show how the institutions and authorities were aware of the need for a structured and centralized solution.**

1. **The first event** was the ruling of the Constitutional Chamber of the Supreme Court of Justice in May 2012, which ordered the CCSS to implement and execute the EDUS project. The court reached this decision after hearing the petition for protection of constitutional rights filed by a user after having two appointments canceled, one at the Urology Service and the other at the Neurosurgery Service, because his physical file was lost. In Vote No. 6559-2012 of May 23, 2012, the justices of the Constitutional Chamber unanimously ruled against the Executive Presidency and the Board of Directors of the CCSS in this case and ordered them to implement and execute the EDUS project within a reasonable timeframe because of how the lack of such a system was impacting people's right to health.

2. **The second event** was when the CCSS Board of Directors created an Implementing Unit to implement, manage, and administer the EDUS in a centralized manner. The Board also declared the EDUS to be an institutional priority.[20, 21] It approved these steps in May 2012, following the Constitutional Chamber's ruling. However, the idea of centralizing the initiative and giving it priority had been present since at least 2010, when a project profile had been completed.

3. **Finally, the third event** was the introduction in 2012 and passage in July 2013 of Law No. 9162 to strengthen EDUS. This initiative established the scope and mechanisms for *"(...) planning, financing, supplying, resourcing, and implementing a centralized digital health record, nationwide"*:[22] It also declared EDUS to be an institutional priority and set a five-year deadline for its implementation at all levels of care.

These three events created a positive context for launching the project and also gave momentum to a new implementation approach, which differed from previous attempts to execute an electronic health record system in two ways. First, it gave the EDUS the status of a national project that transcended governments, political parties, and even

[20] Article 26 of session No. 8577.

[21] Law No. 9162, Unified Digital Health Record, 2013.

[22] Social services audit area, 2016, 10.

the institution itself, and that should at all times have the status of a government policy and not be beholden to special interests. Second, the new approach recognized the electronic record system as a highly complex project that, instead of being just a matter of IT solutions or purchasing software, involved different operational, administrative, medical, IT, and political concerns within the CCSS.

This second divergence in approach was what prompted the project to be moved from the Information Technologies Department– where it was treated as a software program — to the Infrastructure Management Unit, where it would be developed as a comprehensive clinical management and digitization project. Against this backdrop, the CCSS began implementing the EDUS.

The timeline below summarizes the main events that led to the creation and implementation of the EDUS.

4.2. EDUS implementation process

» **Once the Implementing Unit was created, the CCSS began to implement the EDUS in stages, progressively, and at different levels of the Costa Rican health system.**

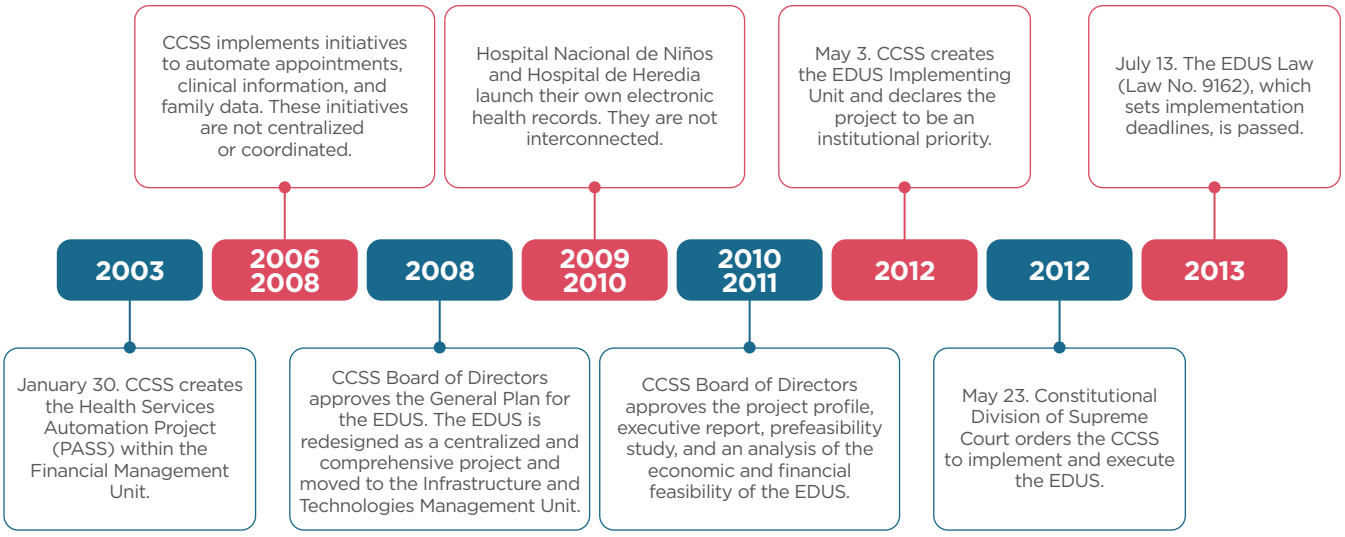
From 2013 to 2018, the project was gradually activated at the facilities of the health system's three levels.

The first stage was primary care, which consists of the EBAIS and health areas. This level was chosen as the starting point because it is the entry point for Costa Rica's health services. It is where users enroll and where *"preventive medicine, (...) the foundation of the whole system"* takes place (Murillo-Jenkins, 2022). Once the EDUS had been implemented at primary care facilities, the process then began at the secondary and tertiary levels— at general, specialized, regional, and peripheral hospitals.

On September 25, 2018, the CCSS announced that it had fully implemented the EDUS at all three levels of health care and at all health areas, EBAIS, and hospitals in the country (Office of the President of the Republic of Costa Rica, 2018), thus meeting the deadline set by Law No. 9162.

Instead of fully activating all systems and all health facilities in the country at the same time, EDUS components were deployed and used in stages, as they were designed or refined. The process was also somewhat gradual at each health facility, regardless of its level. The process was marked by a progressive approach internally at each level of health care, as well as at each medical facility and in the EDUS itself.

FIGURE 7: Timeline with the main events leading up to the EDUS



Source: Prepared by the authors.

This progressive roll out is illustrated by certain operational decisions made in two main areas: coverage and EDUS subsystems. For example, the EDUS was not launched simultaneously across the entire primary care level. Rather two health areas and their respective EBAIS were added each month, allowing decision-makers to evaluate the functionality and interoperability of the systems that they need to activate in each of these regions. Likewise, when the systems were in operation at these facilities, they continued to use their previous methodology (whether digital or analog) to some extent, in order to make the change less abrupt for the staff. As personnel became more familiar with EDUS, the facilities gradually phased out the old ways of working until they were no longer part of daily tasks.

The EDUS's different systems were not implemented simultaneously at all hospitals and specialized health centers either. Rather, those in charge of the project strategically picked facilities for a tiered and gradual rollout.

Chronologically, the CCSS began implementing the different EDUS systems and activating the different stages in 2013, after Law No. 9162 passed. That year marked the start of the first stage, which was implementing the EDUS at all CCSS primary care facilities.

The first systems to be implemented were the SIAC (Integrated System for Enrollment, Scheduling and Appointments), the SIFF (Integrated Family Record System), and the SIES (Integrated Health Record System). Before creating the EDUS, these systems operated as standalone, technologically independent platforms with no connection to the EDUS. For that reason, the CCSS had to work to make them part of the EDUS and interoperable with each other.

Several highly complex tasks were carried out during this stage. For example, the information in the SIFF had to be updated and completed with data on the place and conditions of residence of all individuals, as well as their basic health history. This information had to be completed in this first stage so that when someone went to a secondary or tertiary level health center, the respective authorities would already have digital records of their medical history.

The second stage of EDUS implementation, at hospitals and specialized centers at the secondary and tertiary levels, began in 2016. That year, the CCSS activated the hospital admission/discharge system, rolled out the surgical module (ARCA), and launched the Emergency Department Integration System (SIUR) at hospitals.

In official communique No. EDUS-0564-2016, the CCSS stated that it would not upload any historical data (paper records) into the new Digital Health Record system for technical reasons and because it did not believe the cost-benefit ratio of doing so would be satisfactory.[22]

The third phase commenced in 2018, once the EDUS had already been implemented at the three levels of care. This third stage consisted of deploying the remaining systems. From 2018 to 2022, the SILC (Integrated Clinical Laboratory System), the SICI (Integrated Cytology System), the SIVA (Integrated Vaccination System) and the SIVE (Integrated Epidemiological Surveillance System) were all activated at CCSS facilities. The last system to be integrated into EDUS was the SIFA (Integrated Pharmacy System).

» **The CCSS changed the way it measured the EDUS's implementation as the project progressed in the country.**

Initially, coverage was used as the key indicator, under the understanding that the EDUS would be considered a success "when 100% of the EBAIS used the system" (Rodriguez Arce, personal correspondence, 2022). The CCSS then switched to measuring clinics' need to use the EDUS and their

FIGURE 8:
Timeline: Stages of implementing the EDUS at the CCSS

	Stage 1 2013 • 2016	Stage 2 2016 • 2018	Stage 3 From 2018 onward
Systems activated	SIES, SIAC and SIFF are activated.	The hospital admission and discharge module and the surgical module (both part of the ARCA system) are activated, separately. In addition, the SIUR and scheduling and appointments module (part of the SIAC) and the records module (within the SIES) are activated.	The remaining systems are activated: SILC, SICI, SIVA, SiVE, and SIFA.
Levels of healthcare involved	**Primary care level:** EBAIS and health areas.	**Secondary and tertiary level:** Level II health areas, hospitals and specialized centers.	

Source: Prepared by the authors.

consequent dependence on the tool (Barrantes, personal correspondence, 2022). Figure 8 contains a timeline summarizing this process.

4.3. The EDUS today: direct and collateral benefits

On July 16, 2018, once the EDUS had been activated at all three levels of health care, the CCSS Board of Directors decided to make the EDUS Implementing Unit a permanent body of the organization. It thus entered the phase of cementing the project as a permanent program within the institution. As described in the Sulá Batsú report (2018), it was *"time to move toward being more predictive and proactive, letting people know about the health risks they would likely face in the future"* (Rodríguez Arce, personal correspondence, 2022). That same report, based primarily on interviews with medical and administrative professionals and patients, **lists the following benefits of the EDUS (Sula Batsú, 2018, 158-195):**

- **It saves time** in care processes and helps services stay on schedule by simplifying procedures and reducing the time it takes to prepare and move documents related to medical appointments.
- **It improves the quality of information available** for decision-making by reducing contradictions and duplications through better traceability, portability, and processing of data in digital format. Geographic information has also been very important.
- **It standardizes procedures,** making it easier for health specialists from different areas to crosscheck information. This standardization also makes it possible to perform comparative analyses over time and between different centers, as well as to generate projections and statistics that provide valuable input for work plans and for allocating resources.
- **It boosts productivity.** The EDUS makes it easier to track the work of CCSS staff: productivity has risen among primary care professionals because activities and patient care are now recorded using the EDUS.
- **It enables predictive analysis capabilities,** since the data generated by the system is used for preventative medicine and to predict the behavior of some diseases, thus supporting epidemiological surveillance.
- **It narrows the digital divide** by enhancing digitization through increased technological equipment and training in technology for CCSS personnel. This benefit has closed the digital gap between the different health centers.

The EDUS has also provided benefits to specific healthcare areas.

- **In emergency medicine,** the EDUS has helped ERs take a data-driven approach to prioritizing patients, which has streamlined care, strengthened integration between areas, and optimized care flows.
- **In pharmacy,** the EDUS has cut medication delivery times down by at least one hour, improved the organization and control of inventories and medication delivery, and has made prescriptions more legible.
- **In nursing,** the EDUS has enhanced primary care by making information more available and more traceable, and it has allowed departments to crosscheck information to avoid redundant requests.

- **In terms of utilization, as of February 15, 2022, the EDUS had supported over 63 million healthcare actions and more than 76 million outpatient appointments.**

The EDUS' direct and collateral benefits. One of its direct benefits was prompting a change in the process of care and how health services are organized.

Additionally, in 2019, the CCSS activated a module to provide an overview of the status of the compulsory pension (Barquero, 2019). While this important step forward is not directly related to health, it does fall within the institution's mandate, which also includes managing disability, old age, and death pensions.

Interoperability with the Supreme Electoral Tribunal (TSE) systems[23] was another decisive step for the EDUS. Prior to EDUS, Costa Rica's health services had to generate a medical death certificate through a process involving several administrative steps, and the certificate did not appear in TSE systems until six months later. In the digitized process, the EDUS automatically generates the certificate and shares it directly with the electoral body. This change streamlined bureaucratic, insurance, and other processes for the relatives of the deceased.

TABLE 3:
EDUS productivity report

Description	Total
Outpatient appointments	76,753,839
Appointments for procedures	9,291,284
Emergency care actions	27,985,965
Medical care actions	63,823,199
Prescriptions	466,874,477
Lab test requests	28,730,229
Imaging study requests	1,592,722
Appointment reminder SMS	21,558,875
EDUS Management SMS	539,006

Source: (Macaya-Hayes, 2022).

[23] The Supreme Electoral Tribunal (TSE) is a body established by the Constitution that is responsible for organizing, overseeing, and monitoring all electoral processes in Costa Rica. It is also in charge of the country's identification service, as it oversees the Civil Registry, so it has to systematize all vital events like births, adoptions, marriages, divorces, deaths, or changes in nationality. Additionally, it is responsible for preparing the electoral rolls and issuing the identity cards of all Costa Ricans.

The EDUS has gained momentum as a successful project that can provide solutions to people from different communities within the country. When this case study was written, the systems were in the process of recovering from a series of cyberattacks against the institution in 2022. At that time, 99% of CCSS appointments were being made through the EDUS (Macaya-Hayes, 2022).

4.4. The future of the EDUS: challenges and unresolved issues

The EDUS has a series of challenges that have to be overcome to improve the tool, guarantee Costa Ricans' right to health, and protect them when their data is being processed. **These challenges fall into three main categories.**

1. **The first is the project's governance.** The EDUS's current place within the CCSS's organizational structure needs to be reconsidered. Several interviewees[24] remarked that the project is already entrenched in the institution and that the CCSS therefore needs to decide which management unit will be in charge of it, retaining its focus on innovation and digital health.
2. **The second category is the user experience.** Focus groups clearly considered the EDUS to be an essential tool for healthcare services, but also saw room for improvement. Users requested that biometric technologies like fingerprint reading or facial unlocking be added to the mobile app to make access easier for those who have difficulties with passwords. They also said the system for requesting appointments needed to be improved, by, for example, creating a system that would allow people to manage appointments for family members from their profiles or a by adding a scheduling mechanism that gives preference to those who live farther from the health center.
3. **The third category is using the medical information that is centralized in the EDUS.** The SIAC, SIES, SIVA, SIFF, and other systems are currently crucial sources of biostatistics for the CCSS, and they produce information that is important for making decisions nationwide. But several interviewees believe the future of the EDUS lies in expanding the use of this data to improve healthcare for users and strengthen public health.

Future challenges or difficulties for the EDUS include:

- **Using the EDUS in the private sector.** The EDUS can currently only be used by professionals and users within Costa Rica's public health system. But if someone sees a private dentist, for example, this information does not show up in their electronic record. The CCSS should assess whether it is pertinent and feasible for both public and private entities to be able to see and modify each patient's status and medical history. This would ensure that *"the information always follows patients, since it belongs to them"* (Rodriguez-Cubillo, 2022).
- **Abolishing regionalism in health care.** At the time of this case study, people had to be enrolled in one of the 104 health areas for budgetary reasons. Each area is assigned resources based on the number of patients they are supposed to serve. This region-based enrollment means that if a person is registered in one province, in theory they cannot receive care in another. The EDUS will make it easier to implement another model in which people can receive healthcare in any region. However, achieving this would require a set of administrative and legal reforms that go beyond the scope of the EDUS as an institutional project.
- **Remote health care.** The EDUS makes it feasible to move towards a system that allows patients to record their vital signs and health personnel to track their condition remotely, with a personalized monitoring system. *"There are many patients who don't need to be in a hospital to finish an antibiotic, because they can take it at home. They should continue to be monitored by a health service through the EDUS."* (Murillo-Jenkins, 2022).
- **Greater communication with users.** The EDUS should be used to maximize communication with patients. Through the EDUS, the CCSS can keep in closer contact with people by cell phone. For example, in addition to using the EDUS to "*manage appointments, share lab results, schedule actions, pick up medications at the pharmacy, the CCSS can start to inform*

[24] See reference to interviewees.

patients of their diabetes risk profile, for example, and use the EDUS to give them lifestyle advice to minimize that risk" (Macaya Hayes, 2022).[25]

- **Implementing predictive medicine.** The EDUS can show the epidemiological profile of Costa Rica's population. The CCSS should consider using these profiles to *"build predictive models that provide an overview of how public health is evolving"* (Macaya Hayes, 2022) overall and/or within particular populations, in order to issue early warnings to prevent certain situations.

In dealing with these unresolved issues, the CCSS needs to keep various ethical and legal issues in mind to make sure people's rights are protected in the digital environment, and ensure that their personal data is used in a secure way.

[25] Roman Macaya was Executive President of the CCSS from 2018 to 2022.

5. CHALLENGES DURING IMPLEMENTATION

5. CHALLENGES DURING IMPLEMENTATION

Launching the EDUS required cooperation between several stakeholders. Making arrangements so that all the relevant bodies could talk to each, with a single shared vision, "was very complicated" (Arias-Durán, personal correspondence, 2022).

In this process, the team had to overcome multiple challenges in areas as varied as technological infrastructure, Internet accessibility, human resources, law, communication, and digital literacy. This section provides a brief overview of these challenges.

5.1. Technological infrastructure and connectivity

» **In the area of technological infrastructure and connectivity, challenges were present from the very beginning..**

The decision to start with primary care meant first mapping out the needs of each EBAIS. An assessment found that only 20% of these teams had an Internet connection, and that the existing connections were copper-based and low bandwidth. This same assessment showed that many sites did not even have computers (Murillo-Jenkins, personal communication, 2022).

This meant that health facilities had to be equipped with fiber optics, internet, computers, and even electricity. Beyond equipping these spaces, the EDUS team also had to build capacity for the required technical support.

In some extremely rural and dispersed EBAIS, where it was not feasible to install Internet via cable or fiber optics, the teams had to find alternatives during implementation, like uploading data in other places that do have Internet.

The infrastructure and connectivity challenge also arose during implementation at the secondary and tertiary levels. In these cases, the project had to strengthen the Internet network at hospitals and set up telecommunications rooms to house the necessary equipment. As a result, the EDUS team also had to upgrade air conditioning and electrical systems throughout the country to prevent malfunctions.

Several investments were approved in order to ensure the system would work correctly. For example, in 2017 the CCSS Board of Directors approved a US$201 million contract with ICE[26] to renovate and expand the technological and electrical infrastructure of some health centers (Amador-Zamora and Salas-Montero, 2019). Likewise, the final phase of implementation required large investments in infrastructure and connectivity for the laboratory, pharmacy, and medical imaging modules.

The relationship with ICE was essential to overcoming these challenges and successfully developing the EDUS. The CCSS had initially hired Radiográfica Costarricense (RACSA)[27] for these renovations and expansions, but after some problems, it was decided to involve ICE, which solved the issues related to connectivity, equipment, and the EBAIS's electrical systems.

[26] ICE, or the Costa Rican Electricity Institute, is a state-owned company that provides electricity and telecommunications services in Costa Rica. In the telecommunications market, it offers cell phone and Internet services, business solutions, and other services through Kolbi, the dominant commercial brand in Costa Rica. ICE is the main company of ICE Group, which encompasses other state-owned companies that act as subsidiaries: Radiográfica Costarricense S.A. (RACSA), Compañía Nacional de Fuerza y Luz (CNFL), and Gestión Cobro S.A.

[27] Radiográfica Costarricense is a state-owned telecommunications services company.

5.2. Human resources

In terms of human resources, there were four main challenges.

1. **First, the implementation process had to overcome the resistance of some staff to changes in processes, ways of operating, and habits in medical care.** This required launching a major institutional change management process, with training and spaces to soften opposition to the EDUS.

2. **The second challenge was related to the implementation team.** Initially, the tasks were coordinated by a strategic committee made up of different bodies that monitored all EDUS actions and decisions on a bi-weekly basis. This committee coordinated all the networks. As the project progressed and became more complex, more staff had to be brought on.

   For this reason, the strategic committee decided to adopt a "staff and swap" model. Under this model, the project hired people to cover the day-to-day tasks of people who were already employed by a CCSS health center so that those senior employees could devote all their attention to being part of the EDUS implementation support team. Under this arrangement, the staff working the project were already familiar with the health centers' dynamics.

   The decision to develop proprietary software in JAVA also required recruiting new staff to the information technology division, since the CCSS did not have enough personnel with knowledge in this area.

3. **The third challenge was to shift the responsibilities of some CCSS staff.** As a result of the EDUS, some tasks within the patient care process in Costa Rica were automated, while others were eliminated. For example, the CCSS used to hire personnel exclusively to move paper files of patients with medical appointments from the archives to the offices every day. The digital solution meant that this job was no longer necessary, so they were given work in other divisions.

4. **The fourth challenge involved changing well-established habits for patient care.** For example, to make it easier for professionals to adapt to the new digitalized process, the CCSS reduced the number of patients per hour that each physician was supposed to see from five to four. This gave health professionals a few additional minutes per appointment to learn how the system works (Barrantes, personal correspondence, 2022). This reduced number of four patients per hour has remained in effect.[28, 29]

5.3. Legal challenges

Law No. 9162, which ordered the implementation of the EDUS, decreed that the initiative must meet the availability, integrity, and confidentiality requirements established by the country's existing legislation.

Confidentiality posed legal difficulties, since the regulations on healthcare and on processing information were focused on paper processes. To overcome this challenge, the CCSS had to take steps like modifying the Health Record Regulations, which explicitly require that information be recorded with a pen of *"blue or black ink, legibly."*[30] This provision initially led CCSS employees to refuse to use the EDUS because they were worried about possibly violating the regulations (Murillo-Jenkins, personal correspondence, 2022).

To neutralize this concern, the Board of Directors amended the regulations at meeting No. 8701 on March 13, 2014. The solution involved adding guidelines for entering and storing patient-related information through the EDUS if it was already operational at a given health center.

In the same vein, in 2018 the CCSS had to issue specific EDUS regulations governing the use, ownership, administration, archiving, preservation, security, and transfer of users' health data.[30]

[28] On July 28, 2022, the CCSS Board of Directors of permanently set 15 minutes as the time per patient for outpatient services.

[29] Article 32, Unified digital health record regulations. February 20, 2018.

[30] Unified Digital Health Record Regulations. February 20, 2018. Before these regulations were approved, various stakeholders expressed their views on the matter. For example, in 2016 the Office of the Comptroller General of the Republic published a report on the subject, urging the CCSS to approve the regulations as soon as possible.

These legal difficulties have been resolved over time or with implementation. However, there is still room to improve the system's legal and security aspects. For example, a report by the Office of the Comptroller General of the Republic (CGR) published in April 2022 called for a review of EDUS roles and access profiles and pointed out several inconsistencies related to the lawfulness and security of data processing that need to be corrected.

Despite these pending issues, the fact that the CCSS did overcome various legal obstacles reveals that the EDUS is an institutionally prioritized initiative that is supported by the law (Barrantes, personal correspondence, 2022).

5.4. Communications

During implementation, communication played a central and cross-cutting role. The EDUS had hired a communications expert, and also had support from the CCSS Communications Department. The EDUS communications coordinator said that the strategy was gradual, due to concerns about creating false expectations among CCSS staff and the general public.

The communications strategy initially focused exclusively on press and public relations, but as the process progressed, other stakeholders were included, as well as other departments related to digital communication, marketing, publicity, and communication for change.

» **Social media was a key channel for sharing achievements along the way and building a narrative that conveyed a successful process.**

One notable step was eliminating the physical pay slip, which had been issued monthly to workers at CCSS offices, and replacing it with an e-mail.[31] This was a major technological milestone for the institution.

5.5. Funding

Funding the EDUS was another challenge. The original bill introduced in the Legislative Assembly had a budget item for funding the EDUS. But the bill was modified during the parliamentary process, and these economic resources were no longer included. Article 7 of the final law laid out some guidelines for how public institutions and the branches of government should help the CCSS obtain internal or external financing for the project.

The state was also tasked with developing mechanisms to guarantee the financial sustainability of the project in its pre-investment, execution, start-up, operation, maintenance, and subsequent evolution phases.[32]

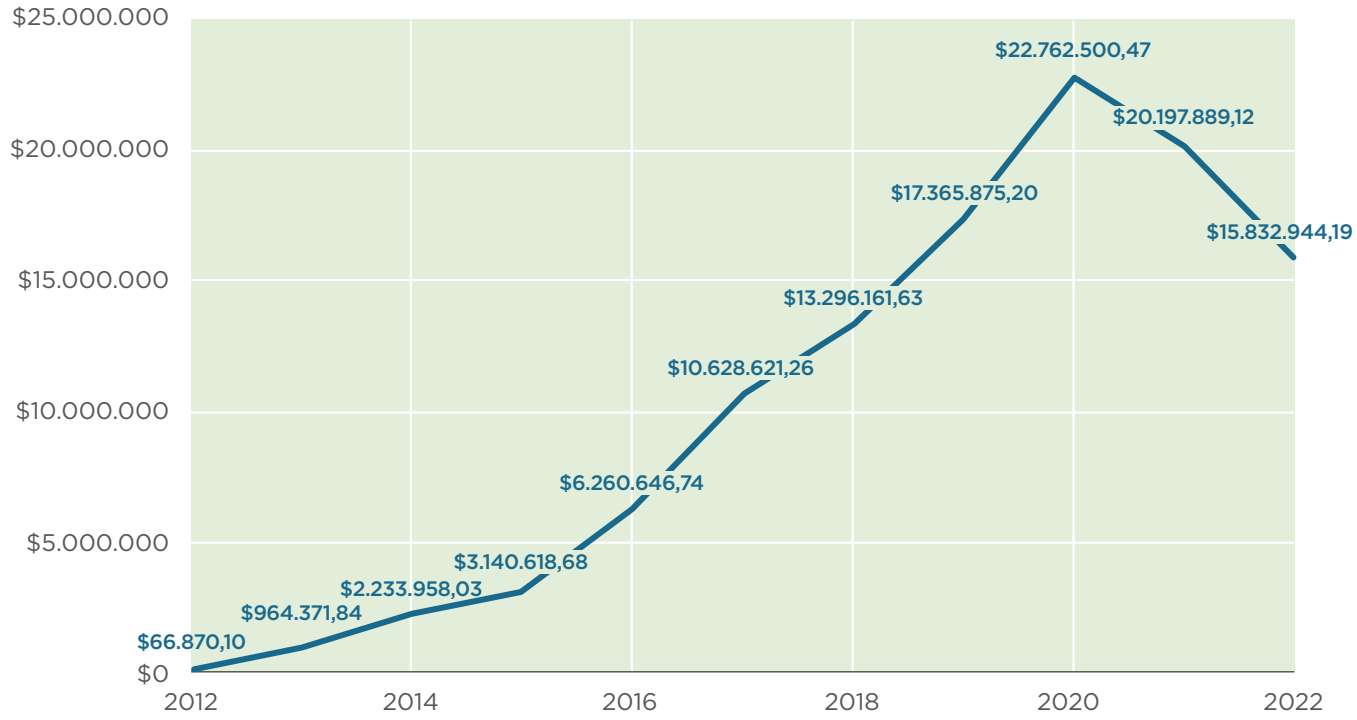
Essentially, the two main changes made to the original bill during the parliamentary process were to set deadlines (five years) and eliminate funding sources (Murillo Jenkins, personal correspondence, 2022).

Due to this situation, the CCSS had to find a way to fund the project with its own resources. Figure 9 summarizes how project spending evolved from 2012 to 2021. It shows a steady increase in spending throughout the implementation period, from §33 million in 2012 (approximately $13,000 at the January 2023 exchange rate) to a peak investment of over §13 billion in 2022 (approximately $23 million at the January 2023 exchange rate).

[31] The pay slip is a document that each employee receives with information on personal and employer contributions to health and pension insurance, as well as his/her gross and net salary.

[32] Article 7, Law No. 9162, Unified Digital Health Record, 2013.

FIGURE 9:
EDUS project spending (2012–2022) in dollars*



Source: Subsidiary ledgers of the CCSS, from 2012-2022.
*The budget is in colones. The conversion to dollars uses the average national accounts exchange rate for each year from 2012 to 2022 from the Central Bank of Costa Rica.

6. THE EDUS AND CHANGE MANAGEMENT

6. THE EDUS AND CHANGE MANAGEMENT

» **One of the biggest successes in the process of implementing the EDUS in Costa Rica was the decision to design a change management methodology.**

"There are a lot of barriers in Costa Rica, so we had to identify all those sticking points and work through them by negotiating, persuading, and asking people and institutions to collaborate. The process involved a lot of convincing, coordination, and gathering support" (Murillo-Jenkins, 2022).

Implementing the EDUS meant *"cultivating a different culture, because the CCSS had been using a paper-based process for 75 years, so we had to foster that culture of change and get out the message that we were going to work in a different way."* (Arias Durán, personal correspondence, 2022). The EDUS experience reflects a process of building a new organizational culture around generating data and statistical information, and around integrating different systems and institutions.

This enormous challenge involved creating change by identifying leaders who would promote the implementation and use of the EDUS at each health unit and at all levels.

6.1. Resistance to the implementation process

The EDUS implementation process encountered internal resistance related to five aspects.

1. **The belief that the EDUS was a form of institutional control.** Some people believed that the EDUS was a way to monitor health care times and procedures, and that it would be used to hassle healthcare staff: *"many people told me: look, if you want, I'll try the EDUS, but until they change the regulations that tell me how I have to do things, I'm not going to use it"* (Murillo-Jenkins, 2022). Overcoming this notion was crucial for implementing the EDUS and getting personnel to use it.
2. **The habit of doing all processes manually.** For all groups, there was the challenge of *"disrupting or changing the organizational culture and getting people to venture out of their comfort zone. We had colleagues who have used physical files for five, ten, 15 or 20 years, and from one moment to the next we had to change their work tools. That wasn't so simple, and people did not embrace it"* (Arias Durán, personal correspondence, 2022).
3. **The generational technology gap.** The project grouped health professionals into three categories of resistance to change: 1) young physicians who had just graduated and had very little resistance to information systems; 2) physicians who had graduated approximately five to 15 years prior, who had a degree of resistance but adapted quickly; and 3) older, more experienced physicians who openly stated that they would not use the digital record system and would not change their methodologies or procedures.
4. **Apprehension about using technology.** The resistance of some CCSS staff stemmed from fear and technology apathy: *"some people were afraid to give the technology a try—a whole generation of professionals who did not even like working with computers."* (Solis, personal correspondence, 2022).
5. **Concerns about the record system's stability.** This resistance is based on distrust of digital records, which is in turn rooted in the fear of leaving behind the stability of paper in the event of a system failure or procedural error. For some, the EDUS signified a *"precarious situation, where at any given moment an outage*

could bring down the whole process."[33] The solution was to make the system more stable in order to protect the credibility of health personnel in the event of potential outages.

There was clear resistance, especially from health personnel, the Union of Medical Specialists (SINAME), and the National Medical Union (UMN).[34] *"At first, they were quite against it. Then when we looped specialists in as test users, that changed"* (Sáenz Madrigal, personal correspondence, 2022). The solution was to train and include staff from medical, nursing, microbiology, and other areas in the development process, allowing them to provide input. Thus, many fears dissipated as people from various medical specialties were incorporated into the change management networks and the coordinating group showed that they would provide ongoing support throughout the implementation process.

6.2. Leadership and networks in change management

As part of managing the change that came with implementing and developing the EDUS, the project created change management networks with leaders who would help with messaging and the initial push to launch the system.

The strategy consisted of identifying and involving leaders from different centers, clinics, and hospitals so that they could lead the way and manage the change with the rest of the staff. These people were trained in soft skills like leadership, assertive communication, emotional intelligence, and empowerment. The CCSS also created change management networks and communication plans for each center, clinic, or hospital.

These leaders were responsible for making sure the EDUS was successfully implemented at the local level. They were called "user leaders" or "EDUS managers" and were specialists from each area (doctors, IT specialists, nurses, and others). In addition, they were familiar with their unit's processes and day-to-day healthcare tasks. At each center, the project created a management team consisting of leaders from the medical, health networks, and nursing departments,[33, 34] among others. This team had the following tasks:

1. Serve as a liaison between the coordinating team and the dynamics of the health centers.
2. Help translate the needs and procedures of their areas into requirements for developing EDUS modules and functionalities.
3. Support the process of learning and peer-to-peer training, reducing resistance to change and to using the EDUS.

The number of people in the networks varied based on the size of the medical center and level of care. For example, at the San Juan de Dios Hospital, the network consisted of approximately 60 people, while at the Los Chiles Hospital, the implementation process was spearheaded by a six-person change management network (Arias Durán, personal correspondence, 2022).

The following positions and teams were created as part of building these networks:

- **Network Service Coordinators:** personnel who planned each of the health service networks.
- **Network support team:** personnel designated by the institutional authorities.
- **Hospital teams:** groups chosen by the senior management of each hospital.
- **Regional teams:** personnel designated by the regional directorates.

These networks were also responsible for peer-to-peer training; that is, medical staff trained their colleagues, nursing staff trained their coworkers, and so on. This made the process easier because there was already a baseline of trust between professionals, and it was a very useful technique because *"it's different when it's a radiologist talking to radiologists, instead of an administrative, IT, or general physician."* (Sáenz Madrigal, personal correspondence, 2022). In addition, including specialists in the change management networks helped mitigate the initial opposition from unions (the UMN and SINAME).

[33] Office of the President of the Republic of Costa Rica, 2020.

[34] Union of medical professionals and surgeons in Costa Rica.

The change management networks also gave each healthcare center a voice in the EDUS implementation process; the networks provided channels of communication that allowed the EDUS project team to assess the specific needs of each unit or even to recruit more change agents.

» **In summary, the networks played a pivotal role in reducing resistance, spreading messages about the change, ensuring that people did not revert back to the previous system, and, in general, getting people to identify with the system to cultivate a culture of change around the EDUS and its potential benefits.**

7. PRACTICES AND USES: THE EDUS FROM THE USERS' PERSPECTIVE

7. PRACTICES AND USES: THE EDUS FROM THE USERS' PERSPECTIVE

» **The transition to digital platforms for managing health information and services has consequences for users.**

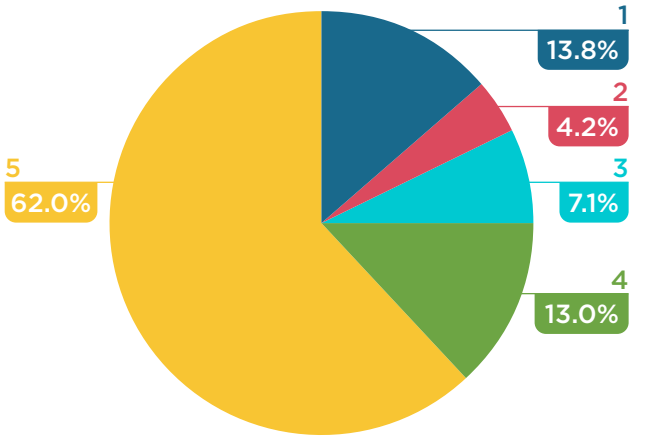
First, a significant percentage of the population supports and values the EDUS. For example, 60% of users give the EDUS app a five-star rating on Google Play (based on six thousand reviews).

In the same vein, a study conducted by Cooperativa Sulá Batsú found that over 79.3% of users "agree" or "strongly agree" with the statement that the EDUS *"helped improve the management and administration of service provision"* (Sula Batsú, 2018).

From the users' perspective,[35] the EDUS *"makes information handy"* and allows them to access their medical records and ensures their rights. Users value the app's flexibility and immediacy as *"a great benefit"* because "*basically the only thing you need to have as a user is internet."*

They are also surprised to be able to use the mobile app to access information like tests, vaccinations, appointments, and pensions. A feature that stands out is the retirement calculator, where people can see a record of social security contributions so they can start the retirement process.

FIGURE 10:
User ratings of the EDUS, on a scale of 1-5



Source: Prepared by the authors based on data compiled by Dr. Óscar Alvarado for a Universidad de Costa Rica research project, 2022.

The EDUS is a *"lifesaver"*[36] that reminds people about appointments and notifies of any scheduling changes. The tool also *"tells you what type of medication patients are taking when they forget and gives an overview of their health problems."*

[35] All quotes in this section are from a users group assembled for this case study (Personas Usuarias CCSS, 2022).

[36] The word used in Spanish is "salvatandas," a Costa Rican colloquialism used in informal contexts. In this case, it means the EDUS provides unexpected help that is useful on a daily basis.

Users call for adding more medical specialties because, as of the completion of this case study, the app could only be used to make appointments with general physicians. They also request more educational processes like video tutorials or guides so they can get more out of the app's features. Additionally, users pointed out challenges with the password and expressed concerns about being locked out of their accounts.

Previous studies have also identified the challenge of creating a system that is adapted to the cultural or linguistic traditions of indigenous peoples, or of developing a platform that people with disabilities can access (Sula Batsú, 2018).

8. THE EDUS AND COVID-19

8. THE EDUS AND COVID-19

» **On March 6, 2020, the Government of Costa Rica reported the country's first case of COVID-19 (Avalos, Lara S. and Recio, 2020).**

In response, the authorities took various measures, including restricting traffic, suspending activities, remote work, closing borders, and mask mandates.[37]

At that time, the EDUS was already ingrained in the culture of the CCSS and its users. This proved to be an advantage when managing the crisis and helped the country keep infection and death rates down during the first two years compared to the rest of the region (Pérez-Laurrabaquio and Rizo-Amezquita, 2022). The EDUS's digitized healthcare process helped Costa Rica track and control the crisis in real time and simplify administrative procedures at medical centers.

The systems for user identification (SIAC), clinical laboratories (SILC), and vaccinations (SIVA) played a key role in tracing vaccination processes and identifying COVID-19 cases.

The CCSS upgraded the EDUS in two ways in response to the pandemic. The first improvement, announced on March 26, 2020 (Rodriguez, 2020), was an update to the EDUS mobile app that allowed users to self-evaluate their risk level (Enriquez and Saenz, 2021). People used this feature to enter their data, and the system calculated their risk of being infected with COVID-19 and communicated that risk using a stoplight system. Green meant low risk and red signified high risk.[38]

The second upgrade was announced in August 2020. The CCSS informed that it had expanded the EDUS to 82 of the 115 labs testing for COVID-19 to count cases more quickly and in an automated way (PAHO and WHO, 2020). The EDUS was also used to notify people when they were infected: the system was used to email or call them based on their contact information.[39]

» **Both measures were added to the ways the EDUS was already being used, allowing the country to monitor the status of the pandemic in real time.**

The EDUS made it possible to systematize information on bed and hospital occupancy levels. This facilitated the logistics of the bed allocation process, because the authorities could use this data to easily locate the places with spaces available to care for COVID-19 patients.

The EDUS also allowed patient information to be consulted from any medical center, so patients could be transferred without worrying that their medical information could be lost: *"If I have to take a patient out of the Heredia Hospital due to overcrowding, and I have to send him to the Alajuela Hospital or the Turrialba Hospital because there is a bed available there, I can open that person's records from wherever he or she is admitted. I don't have to send the file with the patient, which would be logistically very difficult."* (CCSS Employees, 2022).

[37] Executive Decree 42227 National Emergency 2020, Directive 073-S-MTSS. Care and inter-institutional coordination measures in the event of a health alert due to coronavirus 2020, Directive No. 077-S-MTSS-MIDEPLAN. How state institutions operated during the national COVID-19 emergency, 2020.

[38] Office of the President of the Republic of Costa Rica, 2020.

[39] Office of the President of the Republic of Costa Rica, 2020.

» **Additionally, the EDUS allowed authorities to generate automated statistics on cases recorded so they could issue daily reports on the situation in the country.**

This digitized case count made it possible to create other products, like heat maps that showed *"how COVID cases were trending in the country, facilitating both healthcare and prevention and promotion actions"* (CCSS Employees, 2022).

These features were then adapted to other CCSS tasks. For example, the EDUS was used to track CCSS inventories, including vaccines. And the CCSS used home address data to design a home medication delivery program in record time, thus reducing people's exposure to COVID-19.

The EDUS also bolstered telemedicine during this crisis. Teleconsultations have been offered in Costa Rica since 1999, and by 2017 the Telehealth Management Division was already well-established, with 51 physicians from different specialties (Salas Segura, 2020).

But the pandemic drove an exponential increase to 1.7 million remote appointments between March and November 2020, compared to 13,418 in 2019 (Valerlo, 2020). *"It's not like people who get COVID suddenly stop having hypertension or diabetes, and they still need treatment for those other conditions. So we had to set up solutions like over-the-phone telemedicine. And, thanks to the EDUS, physicians already had the information about the patients they were attending"* (CCSS Employees, 2022).

FIGURE 11: Selected uses of the EDUS during the pandemic

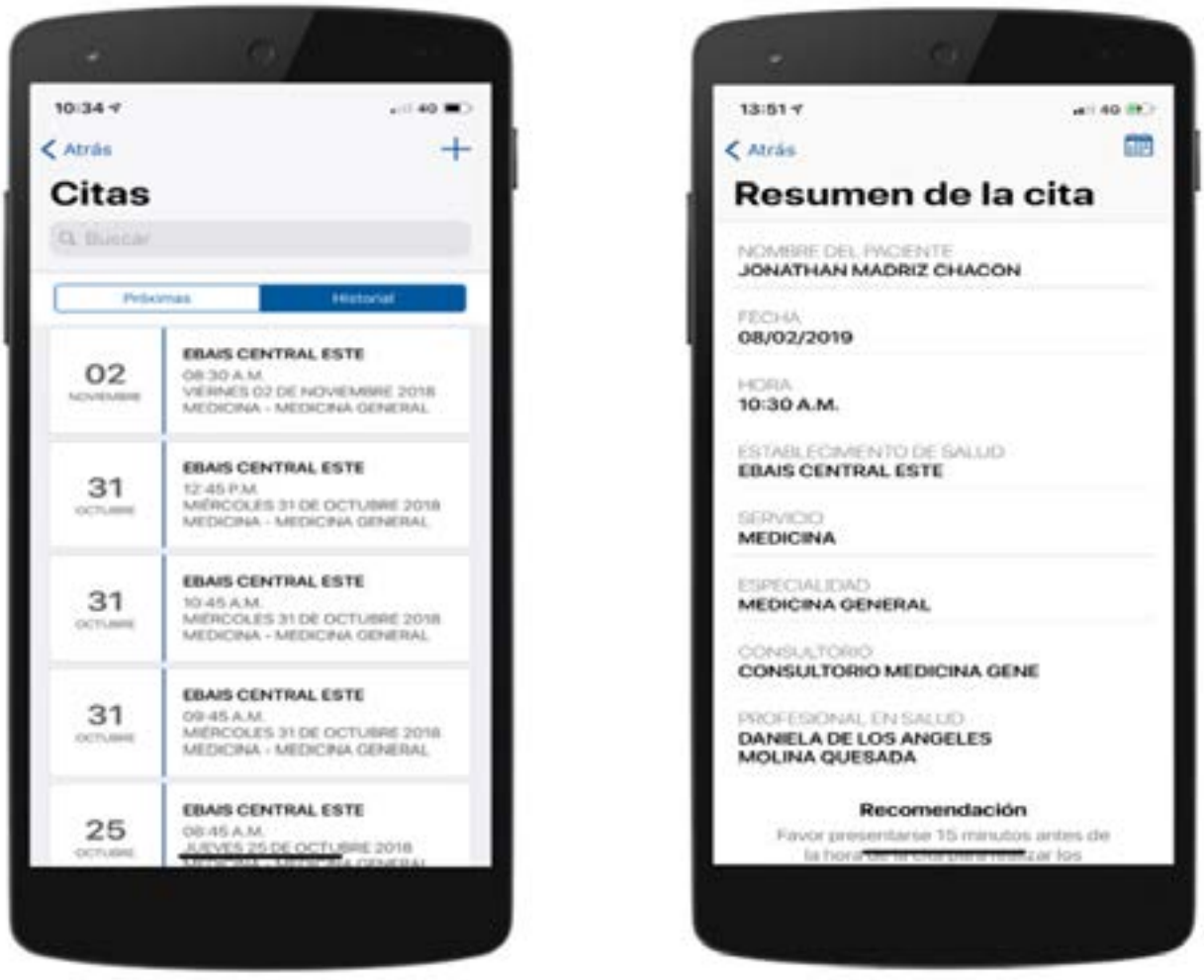
Source: Prepared by the authors based on a discussion group with employees.

Meanwhile, the pandemic triggered a spike in EDUS mobile app downloads and in the app's use among CCSS users. In March 2020, the app had been downloaded 1,555,781 times, and by December of the same year, it had already reached 3,436,530 downloads.

During the pandemic, the EDUS helped reduce trips to health care facilities and the consequent exposure to the virus. At the same time, it provided up-to-date information from a mobile device on clinical laboratory test results, diagnoses, and appointments, keeping people from having to go to health centers in person (CCSS Employees, 2022).

For users, the EDUS played a "heroic" role during the pandemic, and the tool gained popularity among the CCSS staff.

FIGURE 12:
Appointments requested via the EDUS App



Source: Image from the EDUS app website, "CCSS - App Edus" n/d. https://www.ccss.sa.cr/appedus/.

9. THE EDUS AND THE CYBER ATTACKS

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In 2022, nearly 30 government agencies in Costa Rica, including the CCSS, experienced cyberattacks (Vizcaíno, Recio and Lara-Salas, 2022). On May 31, 2022 the Hive Ransomware group attacked the CCSS's human resources portal (Associated Press, 2022). Once the attack was detected, the authorities preventively shut down a number of critical systems (Avalos, 2022), including EDUS, creating a predicament for the entire public health system.

» **While the EDUS' data was not hacked and no personal data was ultimately stolen or altered (Córdoba, 2022), the attacks did obstruct healthcare and lead to canceled medical procedures, confusion, and long lines at hospitals.**

According to CCSS data from June 2022, preventive shutdown of the EDUS partially disrupted health services in the areas of surgery (6%), outpatient procedures (5%), outpatient care (1%), laboratories (2%) and medical imaging (1%) (Cordero Parra, 2022). "On the first day alone, over 500 appointments were canceled, and, afterward, certain complex procedures were postponed indefinitely" (Arroyo, 2022).

During the event, the EDUS's historic achievement of centralizing healthcare information and making it traceable was temporarily reversed. For the first time since the EDUS was fully implemented, CCSS staff was forced to work without it. They had to go back to using physical records, with all their inherent defects.

When the CCSS realized it would take several days to restore the EDUS, *"We decided to pull the physical records out of storage."* This meant segmenting information again and required *"restructuring the whole staff. We didn't have as many people in charge of medical records as before (...) so we had to organize everything again and figure out how to support the records service."*[40]

As part of restructuring care processes, the CCSS had to train the youngest or most recent staff on the "analog" system and the way record keeping worked prior to the EDUS.

Since the cyberattack, CCSS personnel are more aware of the need to create an alternative system for contingencies in order to guarantee the continuity of both health services (CCSS employees, 2022).

The cyberattack also affected users, who often do not memorize the name of their medications or health conditions.[41] When patients would go to a medical center, they could not tell the staff what type of pill they were taking or what surgical procedure they had undergone, which lowered the quality of care.

The consequences were more dramatic for children, as many of them only had digital files. No access to the EDUS meant no access to the information of this entire generation.

[40] Focus group with CCSS employees.

[41] The personal accounts in this section are from the focus group with CCSS employees.

BOX 1

The CCSS without the EDUS: quotes from CCSS employees

"The first week of the cyberattack was madness. We had to provide care to 200 or 300 people per day (...) and many of them did not remember which medications they take. So, that was a huge problem: placing all our trust in patients' memories."

"I can't even begin to describe how exhausting and alarming the cyberattack was. Especially since we have now been working with digital records only for almost four years."

"There were patients who didn't know the names of their treatments, or patients who didn't remember why they had a follow-up appointment or know their medical history."

"Patients came to their appointments with no paper records, no information, not knowing why they were in the hospital or what had happened at the last appointment, which could have been over a year ago (...). There was no information from the last three or four years on any of these people (...). So we had to keep pushing back their care and could not definitively address their problem because we didn't have access to the studies we needed to be able to do so."

"It was horrible. Those born in 2020 or later had no physical files, so we had to start assembling them from scratch."

"Without access to the EDUS, we were at a complete loss."

Source: CCSS Employees, 2022.

From a user perspective, the cyberattack led to **disrupted health services, delays in granting disability status, and problems with requesting medications** due to missing information or dependence on the systems. Users also expressed concern about possibly losing information or about software vulnerabilities.

After a two-month outage, the CCSS reactivated the EDUS app for users on July 22, 2022. The CCSS press release states that *"the database that the EDUS queries is the same source as before the May 31 cyberattack,"* (Cordero Parra, 2022). The CCSS has been gradually reactivating all its systems. Now, *"The CCSS has a permanent monitoring system for early detection of attempted attacks on its systems. In addition, it is developing security strategies in conjunction with the MICITT and other relevant entities"* (Montero Rony, 2023).

10. BEST PRACTICES FOR DEVELOPING AND IMPLEMENTING AN ELECTRONIC RECORD SYSTEM

10. BEST PRACTICES FOR DEVELOPING AND IMPLEMENTING AN ELECTRONIC RECORD SYSTEM

Reconstructing the EDUS implementation process **has yielded a set of best practices and recommendations for designing, developing, and implementing electronic health records, which are presented below.**

10.1. Best practices for design and development

- An electronic health record system **needs to be designed, from the outset, as a national and state project.** When creating the EDUS, the CCSS had support from different stakeholders. On one hand, the Office of the President of the Republic and the Legislative Assembly helped build the political platform needed for the EDUS to become a national project, through the EDUS Law and follow-up on the initiative. On the other hand, the MICITT and ICE played a key role in providing technological connectivity and equipment at the different health centers throughout the country.

- Likewise, **countries may need to modify or adapt their regulatory frameworks** for health systems and other legal instruments if they were designed and created without taking the digital realm into account. This is what happened in Costa Rica, which issued the EDUS Law and amended several regulations and legal instruments.

- **The electronic health record system has to be connected to the entire health system** and the different hospital units and levels. If the electronic health record is only shared between a few health units or facilities, this fragments the information system. This point presents a challenge in countries with decentralized health systems or with multiple healthcare providers.

- Another key decision was to **develop the system internally using a customized process** that allowed the CCSS to control how the software evolved and ensure that it met the institution's specific needs.

- Another noteworthy measure was **establishing people's government-issued ID number as their unique ID in the system,** as required by article 5, paragraph I of the EDUS Law. Finally **developing valuable services such as the mobile app** for users is a best practice.

10.2. Best practices for implementation

The following best practices can be gleaned from the implementation of the EDUS at the different centers and levels of the CCSS.

- **Change management strategy:** managing change at a strategic, tactical and operational level was critically important when implementing the EDUS. The change management network made it possible to reach the entire country and all levels of care.

- **Celebrating achievements:** projects like EDUS are lengthy in any country, so it is important to celebrate victories both small and large with teams to boost morale and energy. Motivation and commitment are essential.

- **Interdisciplinary teams:** it was essential to involve people from various disciplines, like information technology, communication, and medical specialties, covering all areas of the CCSS.

- **Stakeholder mapping:** This strategy was used to identify people with deep knowledge of CCSS processes and systems so they could be agents of change. In addition, both proponents and opponents of the project were identified and invited to be involved through change management.

- **Communication strategy:** Communication was key to implementing the EDUS. The project had to *"communicate at least once a month or once a week: go on the radio, hold press conferences, or take internal communication actions as well."* (Solís, personal correspondence, 2022). **The communication strategy must be cross-cutting and constant,** sharing each milestone achieved to give a sense of continual progress.

- **Training strategy:** This strategy **reduces resistance to change among employees.** As far as possible, training should be peer-to-peer and have two main focuses: training of change managers, on the one hand, and the rest of the staff, on the other.

- **Data security strategy:** It is important **to consider data security from the outset.** For example, training should emphasize how passwords should be robust and handled with discretion.

- **Starting with primary care:** It is recommendable to start the **implementation process at the most basic unit where health and demographic** information is collected, since that is where people are enrolled in the system, whatever its structure.

- **Standardizing processes prior to digitalizing them:** Implementing the EDUS revealed the need for all health centers in the country to have nationally standardized medical procedures and data collection mechanisms. In the past, hospitals and EBAIS had greater freedom to establish their own healthcare processes and collect their data in whatever way they saw fit. The EDUS provided an opportunity to **bring order to all of these processes and apply that order in the digital sphere.**

- **Feedback:** There need to be channels in place to receive **feedback from users.**

- **Inventory of technological infrastructure and connectivity:** To implement an electronic health records system, an institution must have a clear idea of its technological capabilities. Institutions should inventory their i**nfrastructure and connectivity at the facilities where the project will start,** creating a plan for solving any problems that arise.

- **Decreasing patient loads:** If medical professionals are required to see a minimum number of patients per hour, this threshold **should be lowered to help staff adapt to the new process.**

The best practices highlighted above are flexible rather than rigid guidelines. During implementation, institutions should repeatedly evaluate the process so they can adapt the system to their own conditions and needs. This process requires strengthening the internal communication channels with the different parties involved in the implementation.

11. CONCLUDING REMARKS

11. CONCLUDING REMARKS

- **The EDUS's existence is the product of years of collective effort in Costa Rica to enhance the provision of public health services in the country.** And this is one of the main reasons for its success: the EDUS is more than a specific institutional project; it is a state policy that has been championed and strengthened by various political actors, public authorities, and administrations across party and ideological lines.

- As described above, **its good performance is rooted in its governance structure, its modular programming model, and its in-house development and implementation process** that is tailored to a public health system that shapes its characteristics and opportunities.

- **Among other benefits, the EDUS has streamlined healthcare processes, helped medical appointments stay on schedule, improved the quality of information available for decision-making, standardized procedures, boosted the productivity of CCSS staff, strengthened predictive analysis capacity, and narrowed the digital gap between healthcare centers.**

- **The implementation process presented challenges in several areas,** such as technological infrastructure, human resources, regulations, communication, and financing. There were also points of resistance such as technological and generational gaps, as well as fear of technology, of changing entrenched habits, of institutional control over CCSS personnel, and of the lack of stability of the information systems.

- **To overcome these challenges and points of resistance, the project used the change management methodology to involve the various stakeholders.** As part of the strategy, the project organized peer-to-peer training and spoke with users to gather their requests.

- Having emerged intact from the pandemic and cyberattacks, **the EDUS has earned a reputation as a successful project.** Today, neither the CCSS's employees nor its users can imagine the Costa Rican health system without this platform and its various applications.

- **New challenges will obviously arise in the future for the EDUS.** Using artificial intelligence, allowing the private health sector to use and administer the system, using EDUS information for predictive medicine, and strengthening communication with users are all issues that should be addressed promptly so that the initiative remains at the forefront and continues to be useful—as it already has been for the entire insured population of Costa Rica.

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