DIPC

Mapping Vaccine Supply Chain Information Systems: Ministry Of Public Health Of Ecuador

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01
EXECUTIVE SUMMARY

This report provides a comprehensive analysis of the mapping of vaccine supply chain information systems in Ecuador, examining their importance, challenges, and best practices. Through a multidisciplinary approach, it provides a detailed view of how vaccines travel from production to administration, ensuring their availability and efficacy.

02
CONTEXT OF THE STUDY

The global response to the Covid-19 Pandemic has shown the potential of digital transformation to control and mediate health crises. However, to fully harness the potential of digitalization for the early identification and rapid response to pandemics and other health emergencies, digital solutions must be an integral component of comprehensive resilient and equitable health systems that include primary and community health care of hard-to-reach populations. At the same time, data must be available and sharable on regional and global level as a basis for joint, concerted action.

The Andean Amazonian countries, which include Peru and its border countries Colombia, Ecuador, Bolivia and Brazil, face great challenges to adequately meet the needs and expectations of the population in the area of health at the national and local levels. The Coronavirus pandemic demonstrated high deficiencies existing in the system, especially in border regions where health service and vaccine coverage among indigenous communities is low. Regional cooperation in providing access to digital healthcare solutions is especially key in these regions, as populations frequently access health services in several countries. Furthermore, these rural communities are increasingly vulnerable to climate change impacts, heightening not only the risk of public health emergencies, but also of loss of data and access in regions with already low digital connectivity. Regional and bi-regional political dialogue can raise awareness for the high relevance and need of policy alignment in this field, as well as facilitate close cooperation between the EU and LAC regions in future global health emergencies.

In this context, the EU-LAC Digital Alliance Policy Dialogues component is planning to leverage interventions by the Pan-American Health Organisation (PAHO) and the Digital Innovation in Pandemic Control (DIPC) and Data4Policy (D4P) initiatives, funded by the German Ministry of Economic Cooperation (BMZ), to facilitate regional policy dialogue on the potential of regional digital transformation of health services. Within the Policy Dialogues component, this activity is led and coordinated by GIZ as part of the thematic stream on Connectivity and Digital Inclusion. Complementing interventions by Expertise France, FIIAPP and eGA are currently being planned, to establish a coordinated and holistic “Team Europe” approach and address cybersecurity, data governance and interoperability concerns in digital health systems.

Proposed alignment of EU-LAC Digital Alliance with EC-PAHO and BMZ-PAHO partnerships

Under the Global Gateway, the European Commission (EC) has established a partnership with PAHO, aimed at strengthening Latin American and Caribbean access to healthcare technology. It focuses on strengthening regulatory frameworks technologies transfers, increasing manufacturing capacities that remain key drivers to enable in the area of a sustainable pharmaceutical production and private sector investment. The EC funding this partnership with 3 Mio. EUR, with an additional 800.000 EUR contributed by PAHO.

In parallel, the German government is funding the DIPC initiative's activities in Latin America with 1.2 Mio. EUR, in line with its strategic priority on combatting the consequences of the Covid-19 pandemic in German partner countries. The DIPC initiative in cooperation with PAHO, the Ministry of Health of Peru and with the support of the D4P initiative, is strengthening local digital solutions for vaccine delivery, especially for the indigenous population in difficult-to- access border areas of the Amazon region. It seeks to establish the foundations to build digital health infrastructure in partner countries under the GovStack approach, supporting closing the gap in access to digital health services, as well as data-informed decision-making. DIPC's activities in Latin America are a member state contribution of Germany to the EU-LAC Digital Alliance.

Both initiatives present a window of opportunity for the EU-LAC Digital Alliance to contribute to this thematic field with targeted technical assistance and policy-focused interventions. Through coordinated activities, the Policy Dialogues component can:

- Assess the potential for scaling of approaches developed by the DIPC Initiative in Peru to the three neighboring Andean Amazonian countries (Colombia, Ecuador, and Bolivia) with shared marginalised rural and indigenous populations.
- Facilitate consideration of cybersecurity and data privacy risks in the establishment of digital health systems and support the interoperability of systems within and between countries.
- Facilitate high-level regional dialogue based on the experiences of these four champion countries, creating potential for further scaling in other sub-regional communities.
- Create a community of practice surrounding access to health systems for marginalised communities using local digital solutions in the context of the eLAC Working Group on Connectivity led by Peru.
- Set an indicative road map defined to foster digital immunisation systems in the health sector in LAC for the 2024 Summit of Health Ministries of LAC.
- Facilitate bi-regional dialogue towards a common reference framework for equitable and secure access to digital health services in view of the next EU-CELAC Summit.

This framework, in which GIZ has planned three initial activities:

1. **Deliverable I:** Initial assessment and baseline of the digital ecosystem around the vaccine supply chain in three countries (Bolivia, Colombia, and Ecuador).
    a. From the 4th to the 13th of October, GIZ has deployed the consultants to the countries of Ecuador (Dr. Ana Carmela Vásquez)
2. **Deliverable II:** Call to action at the high-level technical dialogue "Digital Transfer and Information Systems" organized by PAHO in São Paulo in November 2023, which presented the initial assessment of digital immunisation systems in Bolivia, Colombia, and Ecuador
3. **Deliverable III:** Defining an indicative roadmap to foster digital immunisation systems in the health sector in LAC, facilitating the high-level dialogue in the context of the 2024 LAC Ministries of Health Summit

    Based on the findings and the call to action, new activities related to inclusive connectivity will be implemented in 2024 and 2025, such as capacity building in the field of digital health for policymakers; as well as for the development of complementary activities led by FIIAPP, eGA and Expertise France.[1]

    The benefits for countries are as follows:

    - **Access to universal health services**
      Universal connectivity allows citizens to seek care for their individual and collective health problems. All this

[1]Concept Note & Indicative Activity Plan "Digital Health" EU-LAC Digital Alliance High-level policy dialogue on digital policy and regulations. GIZ

under a focus on integrated health networks and benefit exchange.

- **Implementation of secure health information systems with offline support**
  It is generally linked online with digitalization; however it is possible to manage digital structures in an offline distributed network and that under certain optimal conditions can notify other network nodes online.

- **Access to quality health products at the regional, sub-regional or national level.** Efficient distribution of drug rotation based on endemic situations of each geolocation.

Objectives of information systems mapping

The objective is to determine the baseline of the vaccine supply chain regarding information systems. The project seeks to support the process of digital transformation in Ecuador in the construction of an integrated information system that allows monitoring of supplies and vaccines from the time they are scheduled until they are immunised to the target population, in addition to being able to share information on the progress of coverage with the countries of the region.

With this, we seek to have real and complete information on the vaccination status of the population living in border areas. This is the first phase in which it is necessary to carry out the situational diagnosis of the current information systems.

Importance of the vaccine supply chain in Ecuador

The supply chain is vitally important for several reasons:

- **Public Health:** The vaccine supply chain is essential to guarantee public health. Vaccines are essential to prevent infectious diseases, some of which can be fatal or cause serious disabilities. An efficient supply chain ensures that vaccines reach the population in a timely and safe manner.

- **Immunisation Coverage:** To achieve high immunisation rates in the population, it is crucial to have a well-organised and efficient supply chain. This includes the correct distribution of vaccines to all regions of the country, including rural and remote areas.

- **Cold Chain Maintenance:** Vaccines often require specific storage and transportation conditions, especially with regard to temperature. A robust supply chain ensures the maintenance of the cold chain, thus preventing the degradation of vaccines and guaranteeing their effectiveness at the time of administration.

- **Rapid Emergency Response:** In situations of disease outbreaks or pandemics, such as COVID-19, an efficient vaccine supply chain is crucial for a rapid response. This makes it possible to control and prevent the spread of diseases effectively.

- **Equity in Health Access:** An effective supply chain helps ensure that all people, regardless of location or socioeconomic status, have access to necessary vaccines. This is essential to reduce health inequalities.

- **Trust in the Health System:** A reliable and transparent vaccine supply chain increases the population's trust in the health system. This is essential to achieve high vaccination rates and for the acceptance of new vaccines.

- **Economic and Social Development:** Controlling and preventing diseases through vaccination contributes to economic and social development. A healthy population is more productive and has a better quality of life.

- **Compliance with International Commitments:** Ecuador, as a member of several international health organisations, has commitments related to public health and disease prevention. An efficient vaccine supply chain is key to meeting these commitments.

Ecuador has made progress in the management of the supply chain of medicines and medical supplies, with technical cooperation from the Pan American Health Organisation (PAHO).

- In August 2022, the Ministry of Public Health of Ecuador participated in a mission to strengthen the supply chain of medicines and supplies to address cases of HIV, tuberculosis, and malaria. The mission was carried out with the technical support of the Pan American Health Organisation/World Health Organisation (PAHO/WHO) in the country.

- In February 2023, Ecuador participated in a workshop organized by PAHO to exchange achievements, progress, and lessons learned in 2022 related to the management of the drug supply chain. The country shared its experience in structuring technical teams for the management of the drug supply chain to ensure access to strategic drugs for HIV, tuberculosis, and malaria. Ecuador also leads the transition of patient cohorts to morecost-effective treatment regimens, such as the use of Dolutegravir in adult and pediatric HIV patients.[2]

- The chain of cold is interconnected with refrigeration equipment that allows vaccines to be stored at recommended temperatures to maintain their potency.[3]

Methodology

This study was carried out using a mixed approach that combined qualitative and quantitative methods to obtain a comprehensive understanding of the research topic. The methodology was divided into two main components: structured interviews and review of public information available on the web.

Structured Interviews

Participant Selection: Key participants who possess relevant knowledge and experience in the study area were identified and selected.

DATE	HOUR	NAME	POSITION[4]	WORK PLACE
20.10.2023	11 a. m.	Lic. Lucia Astudillo	Analyst	National Directorate of Immunisations
20.10.2023	2 p. m.	Dra. Ximena Castillo	Director	National Directorate of Epidemiological Surveillance
23.10.2023	9 a. m.	Mgs. Erica Paulina Carvajal Cerón	Director	National Directorate of Statistics and Analysis of Information of the National Health System
23.10.2023	11 a. m.	Ing. Rodney Eduardo Castro Galarza	Institutional Manager	Management of Innovation and Technological Transformation in Health
23.10.2023	4 p. m.	Psic. Jonathan Andrés Granda Quezada	Clinical Psychologist	National Directorate for User and Patient Management
23.10.2023	4 p. m.	Lcda. Tania Daniela Jácome Olmedo	First Level Care Scheduling and Secondment Specialist	National Directorate for User and Patient Management
24.10.2023	9 a. m.	Mgs. Georlene Patricia Cajamarca Vega	Director	National Directorate for the Supply of Medicines, Medical Devices and Other Strategic Goods
24.10.2023	11 a. m.	Mgs. Paulina Lagla Chicaiza	Task Force Delegate	Advisor to the Ministerial Office
24.10.2023	2 p. m.	Sr. Víctor Hugo Jácome Naranjo Ing. Baber Alberto Moya Lucio	Administrative Assistant Internal Management of Goods, Assets and Warehouses	Administrative Management

[2]Inicia en Ecuador una misión que busca fortalecer la cadena de suministro de medicamentos e insumos para atender casos de VIH, tuberculosis y malaria. (n.d.). PAHO/WHO | Pan American Health Organisation. https://www.paho.org/en/node/88384
[3]Organización Panamericana de la Salud. (s.f.). Health in the Americas 2021. Summary: Regional Outlook and Country Profiles. Washington, D.C.: PAHO IRIS. Recuperado de https://iris.paho.org/bitstream/handle/10665.2/57700/9789275127421_eng.pdf?sequence=1&isAllowed=y
[4]MINISTERIO DE SALUD PÚBLICA - ACUERDO: No. 00023-2022 Reforma Integral a la Reforma al Estatuto Orgánico Sustitutivo de Gestión Organizacional por Procesos

1. **Interview Design:** A structured interview questionnaire was developed that consisted of closed and open questions. The questions focused on supply chain of vaccines.

2. **Interview Process:** Interviews were conducted virtual over a period of 3 days [20/10/2023, 23/10/2023, 24/10/2023]. Each interview lasted approximately [45 minutes] and was conducted in a controlled environment to ensure confidentiality and comfort for participants.

3. **Recording and Transcription:** All interviews were recorded to ensure accuracy in data collection. Subsequently, the recordings were transcribed verbatim for analysis.

4. **Data Analysis:** The interview transcripts were analysed using [mention method of analysis, for example, content analysis, thematic analysis, etc.]. Key patterns, themes and trends were identified that emerged from participants' responses.

03
THEORETICAL FRAMEWORK

Key concepts about vaccine information systems and supply chain

Ecuadorian Health System

The health system in Ecuador is comprehensive and publicly funded, offering free medical care to all residents regardless of income, without the need for purchasing any type of medical insurance. The system is structured and financed by the Ministry of Public Health, the Ecuadorian Social Security Institute, and the private medical sector[5] [6].

The Ministry of Public Health oversees the country's healthcare system, while the Ecuadorian Social Security Institute is the leading provider in Ecuador's health system. The private medical sector also remains active in Ecuador[7].

Ecuadorians have three modes of medical access: (Figure N° 01)

1. **Public Health System:** This is in line with its universal health care coverage, making medical services widely accessible to Ecuadorians with little to no income.

2. **Social Security System:** The working population and their families are entitled to this service, which employees pay through tax deductions.

3. **Private System:** Those who can afford medical care can go to private healthcare facilities. Non-profit medical providers also exist with limited capacities [8].

However, the system is not without its challenges. The public healthcare system is overburdened, struggling to keep up with the demands of an aging population. There is also a lack of trained medical professionals, with many preferring to migrate to better-paying jobs in wealthier South American nations [9].

In response to these challenges, the government made private healthcare mandatory in 2017. This applies to all residents and those who work in the country, subject to a maximum age of 65 years. The laws are quite gentle upon the customer, making it impossible for insurance companies to refuse patients based on pre-existing conditions [10].

In conclusion, while the Ecuadorian health system has made significant strides in providing universal health care, it continues to face challenges that need to be addressed to ensure the health and well- being of all its residents.

However, the objective of the health system is to protect people, contribute to their well-being by enabling them to lead healthy lives and develop nationally. An important factor to consider are the changes in the demographic structure of Ecuador such as aging and new consumption habits that have increased the epidemiological burden of some diseases.

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[5] International Medical Aid. (2022b, marzo 23). Facts about Ecuador's healthcare system. https://medicalaid.org/facts-about-ecuadors-healthcare-system/
[6] [The Health System of Ecuador]. (2011). PubMed. https://pubmed.ncbi.nlm.nih.gov/21877083/
[7] Expat health insurance in Ecuador: The complete guide - Expats Ecuador. (s. f.). https://expatsecuador.com/health-insurance/health- insurance-complete-guide/
[8] Ecuador Expatriate health insurance: Everything you need to know about expat health insurance in Ecuador. (s. f.). Insubuy. https://www.insubuy.com/ecuador-expatriate-health-insurance/
[9] Guzmán, A. M. (2019). Funcionamiento y gobernanza del Sistema Nacional de Salud del Ecuador. Íconos, 63, 185-205. https://doi.org/10.17141/iconos.63.2019.3070
[10] Ministry of Public Health (Ecuador) | GHDX. (s. f.). https://ghdx.healthdata.org/organizations/ministry-public-health-ecuador

In this sense, from the epidemiological point of view, they are in a frank demographic transition, they experience a change in the epidemiological profile at the national level, which is evidenced by comparing the 1990 burden of disease ranking with that of 2019. In 1990, the first and second places were occupied by "Communicable, maternal, neonatal and nutrition diseases", in thirth and fifth place we found "Non-Communicable Diseases"; while for 2019, we see in first to sixth place are Non- Communicable Diseases, that is, "chronic diseases". The financial impact that the latter can represent is high, since they are diseases that continue to be financed for life with all the complications that this could entail, therefore, it directly affects health spending. (Figure N° 02)

Political division of Ecuador

Ecuador is divided into 9 planning zones, each made up of neighboring provinces. This division is based on the geographical, cultural, and economic proximity of the provinces. The National Secretariat for Planning and Development (SENPLADES) is the entity responsible for establishing and coordinating these planning levels. (Figure N° 03)

The planning zones are as follows:

1. **Zone 1:** Includes the provinces of Esmeraldas, Imbabura, Carchi, and Sucumbíos.
2. **Zone 2:** Comprises the province of Pichincha, except for the canton of Quito.
3. **Zone 3:** Covers the provinces of Napo and Orellana.
4. **Zone 4:** Includes the provinces of Manabí and Santo Domingo de los Tsáchilas.
5. **Zone 5:** Comprises the provinces of Santa Elena, Guayas (except for the cantons of Guayaquil, Samborondón, and Durán), Bolívar, Los Ríos, and Galápagos.
6. **Zone 6:** Covers the provinces of Cotopaxi, Tungurahua, Chimborazo, and Pastaza.
7. **Zone 7:** Includes the provinces of Cañar, Azuay, and Morona Santiago.
8. **Zone 8:** Comprises the cantons of Guayaquil, Samborondón, and Durán.
9. **Zone 9:** Covers the provinces of El Oro, Loja, and Zamora Chinchipe.

These planning zones do not eliminate the provinces, cantons, or parishes, but are established for better identification of needs and effective solutions for the provision of public services in the territory. From each zone, the entities of the public sector are strategically coordinated, through the management of planning for the design of policies in their jurisdiction.[11] [12]

Health System Financing

The financing of the Ecuadorian health system is a shared responsibility between the government, the Ecuadorian Social Security Institute (IESS), and the private sector. (Figure N° 4)

The Ministry of Public Health is the primary body responsible for overseeing the country's healthcare system and its financing. It has proposed reforms to the public financing model in Ecuador, focusing on pooling of funds and payment mechanisms [13] [14].

[11] Zonas de planificación de Ecuador. (s. f.). Scribd. https://es.scribd.com/document/364966467/Zonas-de-Planificacion-de-Ecuador
[12] Piedra-Peña, J., & Prior, D. (2023). Analyzing the effect of health reforms on the efficiency of Ecuadorian public hospitals. International Journal of Health Economics and Management, 23(3), 361-392. https://doi.org/10.1007/s10754-023-09346-z
[13] Villacrés, T., & Mena, A. (2017b). Mecanismos de pago y gestión de recursos financieros para la consolidación del sistema de salud de Ecuador. Revista panamericana de salud pública (Impresa). https://doi.org/10.26633/rpsp.2017.51
[14] Financiamiento del Sistema Nacional de Salud Ecuatoriano para la cobertura universal. (2021, 25 agosto).

The Ecuadorian Social Security Institute (IESS) is a significant player in the health system. It is an autonomous entity responsible for implementing mandatory universal insurance, as stated in the Ecuadorian Constitution. The IESS operates its own clinics, dispensaries, and hospitals, and it regulates, administers, and collects contributions to the programmes [15]. The IESS pays 75% of the cost of the benefit, and the employer pays the remaining 25% [16].

The private medical sector also contributes to the financing of the health system. International organisations and foreign entities also contribute to the financing of Ecuador's health system. For example, the European Investment Bank (EIB) has provided financing for a healthcare project supporting a childhood vaccination campaign in Ecuador [17]. The World Bank has also provided financial support to Ecuador to strengthen its health response to COVID-19[18].

In conclusion, the financing of the Ecuadorian health system is a collaborative effort involving the government, the IESS, the private sector, and international organisations. In addition, it is necessary to specify that through the PRAS Computer System, the entire population is assigned to a first-level health care facility, that is, regardless of whether it is insured by social security, the entire population is enrolled in all first-level care facilities of MSP. If care is provided in the MSP facilities, funding is requested later.

Ecuador's health expenditure represents 8.1% of the Gross Domestic Product (GDP), equivalent to USD 8.820 billion per year, according to a study conducted by the International Labor Organisation (ILO)19. This percentage has grown by 2.3 percentage points in the last decade [20]. (Figure N° 04 and 05)

It is important to note that, of this total health expenditure, 40% is financed by Ecuadorian households. In comparison, in countries like Brazil and Colombia, the participation of household spending on health is 28% and 15% respectively.

As for public spending on health, in 2017 it reached 4.36% of GDP, which represented an increase of 0.12 points compared to 2016, when it was 4.24% of GDP [21].

The Constitution of Ecuador establishes that the General State Budget allocated to health will increase each year by a minimum of 0.5% of GDP, until reaching at least 4%. However, this goal is not always met. For example, in 2020, 4% of GDP was about USD 3.952 billion, but the Government designated an initial budget of USD 3.067 billion[22].

In summary, health spending in Ecuador, both public and private, represents a significant percentage of the country's GDP, although there are still challenges to meet the objectives set out in the Constitution.

Vaccine Financing in Ecuador

The financing of the regular vaccination scheme in Ecuador comes from several sources. The Ministry of Public Health (MSP) of Ecuador is the main body responsible for the acquisition of vaccines in the national scheme[23]. The MSP has a budget allocated for the purchase of vaccines, cold chain equipment, and other necessary supplies for the implementation of the Expanded Programme on Immunisation (PAI)[24].

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[15] UNOPS and Ecuador sign new agreement to strengthen public healthcare - Ecuador. (2023, 29 junio). ReliefWeb. https://reliefweb.int/report/ecuador/unops-and-ecuador-sign-new-agreement-strengthen-public-healthcare
[16] Social Security Programs Throughout the world: The Americas, 2019 - Ecuador. (s. f.-c). Social Security Administration Research, Statistics, and Policy Analysis. https://www.ssa.gov/policy/docs/progdesc/ssptw/2018-2019/americas/ecuador.html
[17] Financiamiento del Sistema Nacional de Salud Ecuatoriano para la cobertura universal. (2021, 25 agosto). https://www.ilo.org/lima/publicaciones/WCMS_817788/lang--es/index.htm
[18] Mahabir, D. F., Shankardass, K., Freiler, A., O'Campo, P., Brisbois, B., & Muntañer, C. (2022). How and why buy-in for health in all policies was facilitated in Ecuador: A realist case study of Plan Nacional para el Buen Vivir. International Journal for Equity in Health, 21(1). https://doi.org/10.1186/s12939-022-01703-7
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[21] Financiamiento del Sistema Nacional de Salud Ecuatoriano para la cobertura universal. (2021, 25 agosto). https://www.ilo.org/lima/publicaciones/WCMS_817788/lang--es/index.htm
[22] Gasto en salud. (s. f.). Base de datos de inversión social. https://observatoriosocial.cepal.org/inversion/es/indicador/gasto-salud
[23] Mundial, B. (2021, 4 abril). El Banco Mundial aprueba US$150 millones para apoyar la vacunación contra la COVID-19 en Ecuador. World Bank. https://www.bancomundial.org/es/news/press-release/2021/04/05/el-banco-mundial-aprueba-us-150-millones-para-apoyar-la- vacunaci-n-contra-la-covid-19-en-ecuador
[24] ORGANIZACION PANAMERICANA DE LA SALUD [OPS] (Ed.). (2017). Evaluación de la Estrategia Nacional de Inmunizaciones Ecuador 2017 (1.a ed.). OPS. https://www.paho.org/en/file/46904/download?token=Bhe-5g_1

In addition to this, international organisations such as the World Bank also provide financing to support immunisation in Ecuador. For instance, the World Bank approved a financing of US$150 million to support COVID-19 vaccination in Ecuador[25]. Although this financing was specifically allocated for the COVID-19 pandemic response, it demonstrates the type of international financial support that can be available for immunisation in Ecuador.

It's important to note that while the MSP is the main body responsible for the acquisition of vaccines, the implementation of the immunisation programme also relies on collaboration with other sectors of the government, as well as non-governmental organisations and civil society[26].

In summary, the financing of the regular vaccination scheme in Ecuador primarily comes from the MPH's budget, with additional support from international organisations and other sources as needed.

Revolving Fund

The Pan American Health Organization's (PAHO) Revolving Fund is a mechanism of solidarity cooperation that allows for the purchase of vaccines, syringes, and related supplies on behalf of participating Member States. This fund has been in operation for over 40 years and has provided access to safe, quality vaccines at affordable prices to Member States and territories in the region.[27]

The Revolving Fund works by consolidating the vaccine demand of participating countries, leveraging economies of scale, promoting transparent negotiations with suppliers, and implementing innovative procurement strategies. This enhances their purchasing power, thereby lowering vaccine prices and contributing to the sustainability of national immunisation programmes [28].

The Revolving Fund assists countries in accurately estimating their vaccine and related supply needs, consolidates regional demand so that vaccines can be purchased wholesale at the lowest price, prepares and directs transparent tenders for qualified products and suppliers, processes the results of competitive tenders into purchase orders for countries, and oversees international shipping to countries.[29]

Health Information System

A health information system is a set of elements aimed at processing and managing data and information, organized and ready for later use, generated to meet a need or objective in the field of health[30]. This management mechanism of interoperable systems with open data from different sources is used ethically, through effective ICT tools, to generate strategic information for the benefit of public health[31].

The elements that make up a health information system can be people, data, activities or work techniques, and general material resources, which interact to process data (including manual and automatic processes) and generate more elaborate information [32]. This information is distributed in the most appropriate way possible within a given organisation, depending on its objectives [33].

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[25] Staff, R. (2021, 8 junio). Ecuador tiene asegurado financiamiento para plan de vacunación: ministro Economía. U.S. https://www.reuters.com/article/salud-coronavirus-vacunas-idLTAKCN2DK2DV
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[30] Sistemas de información para la salud. (s. f.). OPS/OMS | Organización Panamericana de la Salud. https://www.paho.org/es/temas/sistemas-informacion-para-salud
[31] Canela-Soler, J., Elvira-Martínez, D., Labordena-Barceló, M. J., & Loyola-Elizondo, E. (2010). Sistemas de información en salud e indicadores de salud: una perspectiva integradora. Medicina Clínica, 134, 3-9. https://doi.org/10.1016/s0025-7753(10)70002-6
[32] Sistemas de Información en salud | Buenos Aires Ciudad - Gobierno de la Ciudad Autónoma de Buenos Aires. (n.d.). https://buenosaires.gob.ar/propuestas-formativas/sistemas-de-informacion-en-salud
[33] Pablo, L. S. J. (s. f.). Sistemas de información en salud: ¿como prevenir el desencanto de la nueva tecnología? http://www.scielo.sa.cr/scielo.php?pid=S1409-12591998000200003&script=sci_arttext

Information systems are closely related to the data lifecycle (capture, transmission, storage, processing, retrieval, and distribution). In a practical sense, we understand that they are an organized set of elements, which can be institutions, people, hardware, software, data, documents, activities, exchange protocols, etc., that interact with each other to process data and information (including manual and automatic processes), in order to distribute it in a timely manner within the macrosystem and its components. depending on the defined strategic objectives[34].

The public health information system is conceived as a dynamic and progressive process that allows for the systematic collection of data, orderly consolidation, and evaluation of these and the timely dissemination of results to those in a position to make decisions related to Public Health [35].

In addition, health information systems are essential for decision-making in health institutions [36]. They allow standardising, integrating, and organising all available health information in their information systems, in an accessible and secure repository, as well as the distribution of information in the most convenient way, to facilitate decision-making.[37]

In summary, a health information system is an essential tool that enables efficient management of data and information in the field of health, facilitating decision-making and contributing to the well- being of the population.[38] (Figure N° 06)

Fragmentation and disaggregation of information

Fragmentation and disaggregation are problems inherited from the conformation and organisation of the health system. These are reflected in information management and become important in data processing. The coexistence of different data recording modalities contributes to this regard; Reflecting this is the multiple sources of information within a level and between levels of care. In this sense, not only is there a lack of integration of the different levels of care, but also within the subsystems [39].

Challenge in vaccination coverage

Specific areas of Ecuador that have experienced low vaccination coverage in the regular schedule since 2020 include the provinces of Morona Santiago, Sucumbíos, and Guayas[40]. (Figure N° 07)

In the province of Morona Santiago, vaccination coverage has been one of the lowest in the country. Although the over-65 population has reached a vaccination rate of 85.21%, the rest of the population has not been vaccinated or has only received one dose [41].

In the province of Sucumbíos, it is considered a risk and endemic area for yellow fever. Although vaccination coverage in this area is not specified, the Ministry of Public Health of Ecuador has maintained epidemiological surveillance and vaccination in these areas [42].

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[34] Ramírez, L. C. V. (2016). Los sistemas de información para la Gerencia en Salud Pública. https://www.redalyc.org/journal/4655/465549558009/html/
[35] Orozco, F., Guaygua, S., Villacis, D. H. L., Muñoz, F. M., & Urquía, M. L. (2021). Vinculación de datos administrativos y su utilidad en salud pública: el caso de Ecuador. Revista panamericana de salud pública (Impresa), 45, 1. https://doi.org/10.26633/rpsp.2021.9
[36] Pablo, L. S. J. (s. f.). Sistemas de información en salud: ¿como prevenir el desencanto de la nueva tecnología? http://www.scielo.sa.cr/scielo.php?pid=S1409-12591998000200003&script=sci_arttext
[37] Torab-Miandoab, A., Samad-Soltani, T., Jodati, A., & Rezaei-Hachesu, P. (2023b). Interoperability of Heterogeneous Health Information Systems: A Systematic Literature review. BMC Medical Informatics and Decision Making, 23(1). https://doi.org/10.1186/s12911-023- 02115-5
[38] What is a Health Information System? (n.d.). Digital Guardian. https://www.digitalguardian.com/blog/what-health-information- system
[39] Luna, D., Otero, C., Plazzotta, F., & Campos, F. (2018). Sistemas de Información para la Salud (1.a ed.). Fernán González Bernaldo de Quirós. ISBN 978-987-46479-3-1
[40] Evaluación de la Estrategia Nacional de Inmunizaciones Ecuador 2017 available from: https://www.paho.org/en/file/46904/download?token=Bhe-5g_1
[41] La prolongación de la crisis sanitaria y su impacto en la salud, la economía y el desarrollo social available from: https://repositorio.cepal.org/server/api/core/bitstreams/5d7d5402-188b-4d6a-8d0c-49eec0709554/content
[42] Ecuador: 3.4 millones de niños fueron vacunados e inicia la tercera fase de la campaña. (s. f.). OPS/OMS | Organización Panamericana de la Salud. https://www.paho.org/es/noticias/3-8-2023-ecuador-34-millones-ninos-fueron-vacunados-e-inicia-tercera-fase-campana

The 2023 Pan American Health Organisation (PAHO) report notes that vaccination coverage with the first dose of the measles, rubella, and mumps (MMR1) vaccine decreased in 16 countries and territories in the Region of the Americas between 2020 and 2021, with Ecuador being one of the countries with the largest decline [43].

Health Information Systems – Vaccine Registry in Ecuador

Ecuador does not have a single way to register vaccination attendance, it has about 4 systems that allow registration such as: PRAS, RDACA, DHIS2, SIGOS, SAIZE, among others.

PRAS

The Health Care Registration Platform (PRAS) is a system used in Ecuador's public healthcare system. This system is part of Ecuador's efforts to strengthen its Health Information Systems, as promoted by the Pan American Health Organisation. The goal is to equip the Ministry of Public Health of Ecuador with the knowledge and technical capacity necessary for the development and implementation of electronic clinical documents (HL7, CDA, FHIR) that allow the technical integration of the information subsystems [44] [45].

One of the key outcomes of this project is to empower civil society, academia, and public and private institutions through the establishment of a National Network of Information Systems for Health. This network will strengthen the use of interoperability standards in health in the National Health System of Ecuador through training that includes both the Ministry of Public Health and other related entities. This training will allow the use of interoperability standards to be institutionalized and will lead to the fulfillment of Ministerial Agreement MSP 009-2013 using HL7[46].

In addition to the PRAS system, telemedicine is also allowed in Ecuador. The Ministry of Public Health defines telemedicine as 'the provision of distance medical health services, using information and communication technologies for its implementation.' The Ministry of Telecommunications adds that telemedicine 'is performed by professionals using information and communications technology (ICTs) to exchange data, make diagnoses, recommend treatments, prevent diseases and injuries, as well as for the ongoing training of health professionals in research and evaluation activities, to improve the health of each individual and their communities'[47].[48]

Currently, the PRAS System has all the modules for primary level care, but the second and third level care services, such as hospitalisation, do not yet exist. In order for it to interoperate with other systems, it must be updated.

In summary, Ecuador uses a variety of information systems and technologies, including the PRAS system and telemedicine, to monitor and improve health outcomes. These systems are part of a broader effort to strengthen the country's Health Information Systems and ensure the effective delivery of healthcare services.[49]

DHIS 2

The District Health Information Software 2 (DHIS2) is an open-source, web-based software platform used for data collection, management, and analysis. It is the world's largest Health Information Management System (HMIS) platform, used by ministries of health in 80 low and middle-income countries. Approximately 3.2 billion people (40% of the world's population) live in countries where DHIS2 is used. With the inclusion of NGO-based programmes, DHIS2 is in use in more than 100 countries[50].

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[43] VACUNACIÓN SEGURA: Cadena de frío "Manual de almacenamiento de las vacunas para el Nivel Operativo" available from: https://bancos.salud.gob.ar/sites/default/files/2020-01/0000000441cnt-2013-07_manual-cadena-frio-cdf15x15_imprenta.pdf
[44] Paola Sanchez. (2020, 8 octubre). Plataforma de Registro de Atención en Salud - MSP [Vídeo]. YouTube. https://www.youtube.com/watch?v=1mQ7lNMjJVs
[45] Ecuador will strengthen health information systems by establishing the capacity for design and implementation of electronic clinical documents and management of interoperability standards in health. (s. f.). PAHO/WHO | Pan American Health Organisation. https://www.paho.org/en/information-systems-and-platforms-health/information-systems-health-is4h/is4h-stories/ecuador-will
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[47] AMIA Health Informatics Essentials: Health Information Systems. (2022, 14 enero). AMIA - American Medical Informatics Association. https://amia.org/education-events/education-catalog/amia-health-informatics-essentials-health-information-systems
[48] Estadistica Zona5. (2023b, abril 30). Reporte aplicativo DHIS2 y carga masiva PRAS campaña Vacunacion [Vídeo]. YouTube. https://www.youtube.com/watch?v=hks-WQAR4vs
[49] David Mateo. (2022, 29 julio). Formularios MSP [Vídeo]. YouTube. https://www.youtube.com/watch?v=vqfgn66VgBM
[50] DHIS2. (2023, 20 septiembre). Home - DHIS2. https://dhis2.org/

DHIS2 is designed to meet the needs of public health systems and health workers in low- and middle- income countries. The software is designed and implemented in collaboration with a network of regional HISP groups, who work directly with in-country partners in Ministries of Health and other organisations to ensure that the platform meets their needs[51].

In Ecuador, as in many other countries, DHIS2 is used to collect, aggregate, visualise, share, and analyse health data. The software is free and open-source, and it is designed to work in challenging environments, including areas with limited internet connectivity. The user interface of DHIS2 allows for customisable data entry options, including graphical/pictorial options where relevant, to support areas of lower literacy, including digital literacy.

In addition to its use for routine health reporting at the national, regional, district, facility, and community levels, DHIS2 has also been deployed for specific health programmes and responses. For example, many countries used DHIS2 to respond to the COVID-19 pandemic, building on features and lessons learned from the 2014 Ebola epidemic. DHIS2 toolkits were developed to support COVID-19 surveillance and national vaccine delivery plans.

In summary, DHIS2 is a key component of Ecuador's health information system, providing a robust and flexible platform for the collection, management, and analysis of health data. This system is part of Ecuador's efforts to strengthen its Health Information Systems, as promoted by the Pan American Health Organisation [52].

RDACA

The RDACA (Registro de Datos de Atención en Salud) is a health care data registration system used in Ecuador[53]. This system is part of the country's efforts to strengthen its Health Information Systems, as promoted by the Pan American Health Organisation. The goal is to equip the Ministry of Public Health of Ecuador with the knowledge and technical capacity necessary for the development and implementation of electronic clinical documents (HL7, CDA, FHIR) that allow the technical integration of the information subsystems[54].

One of the key outcomes of this project is to empower civil society, academia, and public and private institutions through the establishment of a National Network of Information Systems for Health. This network will strengthen the use of interoperability standards in health in the National Health System of Ecuador through training that includes both the Ministry of Public Health and other related entities. This training will allow the use of interoperability standards to be institutionalized and will lead to the fulfillment of Ministerial Agreement MSP 009-2013 using HL7[55].

RDACA have a online module and ofline mode, that allow the registry of attention and charge in 2 weeks later and feed the PRAS.[56]

In summary, the RDACA system is a key component of Ecuador's health information system, providing a robust and flexible platform for the collection, management, and analysis of health data. This system is part of Ecuador's efforts to strengthen its Health Information Systems, as promoted by the Pan American Health Organisation [57].

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[47] AMIA Health Informatics Essentials: Health Information Systems. (2022, 14 enero). AMIA - American Medical Informatics Association. https://amia.org/education-events/education-catalog/amia-health-informatics-essentials-health-information-systems
[48] Estadistica Zona5. (2023b, abril 30). Reporte aplicativo DHIS2 y carga masiva PRAS campaña Vacunacion [Vídeo]. YouTube. https://www.youtube.com/watch?v=hks-WQAR4vs
[49] David Mateo. (2022, 29 julio). Formularios MSP [Vídeo]. YouTube. https://www.youtube.com/watch?v=vqfgn66VgBM
[50] DHIS2. (2023, 20 septiembre). Home - DHIS2. https://dhis2.org/
[51] Scaling technology-driven innovation successfully. (n.d.). OECD. https://www.oecd.org/development-cooperation- learning/practices/scaling-technology-driven-innovation-successfully-a6ef90b6/
[52] AMIA Health Informatics Essentials: Health Information Systems. (2022, 14 enero). AMIA - American Medical Informatics Association. https://amia.org/education-events/education-catalog/amia-health-informatics-essentials-health-information-systems
[53] Acuerdos 00002687. Apruébase y autorízase la publicación del Formulario MSP/DNISCG/IA 504-512-2012 'Registro Diario Automatizado de Consultas y Atenciones Ambulatorias-RDACAA'
[54] Ecuador va a fortalecer los sistemas de información para la salud a través del establecimiento de la capacidad para el diseño e implementación de documentos clínicos electrónicos y manejo de estándares de interoperabilidad. (s. f.). OPS/OMS | Organización Panamericana de la Salud. https://www.paho.org/es/sistemas-plataformas-informacion-para-salud-si/sistemas-informacion-para-salud- is4h/historias-21
[55] Choez, X. S., Leal, G., Padilla, Á. M., & Jimbo, R. (2022). Medical cost of acute diarrhea in children in ambulatory care. PLOS ONE, 17(12), e0279239. https://doi.org/10.1371/journal.pone.0279239
[56] Joel Camacho. (2020, 27 septiembre). LLENADO RDACAA MSP ECUADOR [Vídeo]. YouTube. https://www.youtube.com/watch?v=vy1dM1j-Dxe0
[57] https://www.who.int/docs/default-source/inaugural-who-partners-forum/progressing-sdg-case-studies-2017.pdf

The implementation of the health information systems RDACAA (Registro de Datos de Atención y Actividades) and PRAS (Plataforma de Registro de Atención en Salud) in Ecuador has brought several benefits to the country's health-care sector.

1. These systems have significantly improved the management of healthcare services in the country. They allow for real-time registration and analysis of medical care data across all health establishments, which has streamlined the process of patient care and made it more efficient.

2. RDACAA and PRAS have helped to strengthen the country's health information system. They maintain international standards for the electronic exchange of clinical information, which has facilitated interoperability between different health information systems in the country[58].

3. These systems have contributed to the improvement of health research output in Ecuador. The increased volume of scientific output could be attributed to the implementation of these systems, which have strengthened local research capacities and improved population health.

4. The implementation of RDACAA and PRAS has also had a positive impact on the country's response to the COVID-19 pandemic. The World Bank has noted that these systems have been instrumental in the design and deployment of communication campaigns, and other non-vaccine procurement activities.[59]

SAIZE

SAIZE, or "Sistema de Atención Integral de Salud de Ecuador", is a comprehensive healthcare system implemented in Ecuador. It is part of the country's efforts to advance towards universal health coverage and is designed to provide a logical and orderly collection of data in comprehensive health care, with systematic consolidation of information in real time. The system is based on the fundamental pillars of medical ethics, confidentiality, comprehensiveness, quality, and equity, aiming to achieve impactful social results [60].

SAIZE is used in the country's health system to collect and manage data related to health care services. This includes information about patients, treatments, outcomes, and other relevant data. The system is designed to improve the efficiency and effectiveness of health care delivery in Ecuador by providing real-time access to comprehensive health care data.

The use of SAIZE in Ecuador's health system involves several steps. First, health care providers input data into the system during patient visits. This can include information about the patient's symptoms, diagnosis, treatment plan, and other relevant details. The system then processes this data, allowing it to be accessed and analysed by other health care providers, administrators, and policymakers. This can help to inform decisions about individual patient care, as well as broader health care policies and strategies.

In addition to its role in data collection and management, SAIZE also plays a key role in promoting health equity in Ecuador. By providing comprehensive and up-to-date information about health care services and outcomes, the system can help to identify and address disparities in health care access and quality. This can contribute to efforts to ensure that all individuals in Ecuador, regardless of their socioeconomic status or other factors, have access to high-quality health care services.

SIGOS

System that was developed by a local unit, to meet the need for local registration of vaccine application.

[58] https://cdn.who.int/media/docs/default-source/documents/publications/health-of-refugees-migrants-practices-paho- 2018f3274442-4723-4bb7-90f7-

[59] Quizhpe, E., Terán, E., Pulkki-Brännström, A., & Sebastián, M. S. (2022). Social Inequalities in healthcare utilisation during Ecuadorian healthcare Reform (2007–2017): A Before-and-after cross-sectional study. BMC Public Health, 22(1). https://doi.org/10.1186/s12889- 022-12884-9

[60] Granda, M., & Jiménez, W. G. (2019). The evolution of socioeconomic health inequalities in Ecuador during a public health system reform (2006–2014). International Journal for Equity in Health, 18(1). https://doi.org/10.1186/s12939-018-0905-y

Interoperability

Health systems and their medical information systems are in perpetual evolution which makes them different from each other. These different systems compose a heterogeneous, distributed system with high complexity. Thus, interoperability of medical information systems is one of the main challenges of the IT society.[61]

Interoperability is defined as "... the ability of different health information systems to exchange data and use the information that has been exchanged within and across organizational boundaries in order to improve the effective delivery of health care to individuals and communities..." (HIMSS, 2013).[62]

Interoperability is the ability of systems to interact with each other to have mutual benefits. This makes it possible for the organisations involved to share data and information through their respective information systems.[63] (Criado, Gascó & Jiménez, 2010).

In the medical field, it is the ability to share information between components, such as ICT systems or devices, without losing its meaning. This communication should ensure consistent data sharing across departments, organisations, levels of care or regions, such as countries or continents. The main objective is to provide professionals with all the relevant information about their patients to ensure that the decision-making process occurs in a safe, efficient, and effective manner. Interoperability guarantees access to information regardless of where it has been recorded and favors its reuse, minimising blind spots and ensuring the continuum of care. [64]

A **STANDARD** is a "...A document approved by consensus by a recognised body, which provides rules, guidelines and/or characteristics for common use, in order to obtain an optimal level of results in a given context..." (ISO, 2004). In the healthcare field, the use of standards allows both medical devices and health information systems to interoperate with each other.

Within this framework, we have Fast Healthcare Interoperable Resources (**FHIR1; HL7** standard that has been adopted by the healthcare community). This standard seems to be the likely candidate to overcome such a challenge. In addition, it also supports a rich information model that enables interoperability of clinical data. [65]

Digital Transformation

The 2030 Agenda for Sustainable Development emphasizes that the expansion of information and communication technologies and global interconnectedness offers great potential to accelerate human progress, bridge the digital divide and develop knowledge societies. The 2030 Agenda also highlights, in its paragraph 48, the importance indicators have for decision-making[66].

The WHO's Global Digital Health Strategy 2020-2025 recommends that digital technologies be considered "an essential component and enabler of sustainable health systems and universal health coverage." However, concerns remain about the adequacy of the institutional frameworks governing transformative technologies, including privacy and security concerns, and ethical considerations in the use of AI and machine learning [67] [68].

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[61] Torab-Miandoab, A., Samad-Soltani, T., Jodati, A., & Rezaei-Hachesu, P. (2023). Interoperability of Heterogeneous Health Information Systems: A Systematic Literature review. BMC Medical Informatics and Decision Making, 23(1). https://doi.org/10.1186/s12911-023- 02115-5
[62] Epalm. (2021, August 25). Interoperability in healthcare. HIMSS. https://www.himss.org/resources/interoperability-healthcare
[63] Lehne, M., Saß, J., Essenwanger, A., Schepers, J., & Thun, S. (2019). Why digital medicine depends on interoperability. npj Digital Medicine, 2(1). https://doi.org/10.1038/s41746-019-0158-1
[64] Estándares de interoperabilidad en salud .2020- Red Americana de Cooperación para la Salud Electrónica: Serie de libros de recomendaciones técnicas RACSEL
[65] Torres, I., & López-Cevallos, D. (2018). Institutional challenges to achieving health equity in Ecuador. The Lancet Global Health, 6(8), e832-e833. https://doi.org/10.1016/s2214-109x(18)30245-6
[66] Desa, U. (2018). Transforming Our World: The 2030 Agenda for Sustainable Development. En Springer eBooks. https://doi.org/10.1891/9780826190123.ap02
[67] Vidal-Alaball, J., Belmonte, I. A., Zafra, R. P., Escalé-Besa, A., Oliva, J., & Pérez, C. E. T. (2023). Abordaje de la transformación digital en salud para reducir la brecha digital. Atención Primaria, 55(9), 102626. https://doi.org/10.1016/j.aprim.2023.102626
[68] Stoumpos, A. I., Kitsios, F., & Talias, M. A. (2023). Digital transformation in healthcare: technology acceptance and its applications. International Journal of Environmental Research and Public Health, 20(4), 3407. https://doi.org/10.3390/ijerph20043407

The digital transformation of healthcare can be disruptive; However, technologies such as the Internet of Things, virtual care, remote monitoring, artificial intelligence, big data analytics, blockchains, smart wearable devices, platforms, tools that allow data to be exchanged and stored, and tools that allow data to be captured remotely and data and information to be exchanged within the health ecosystem leading to continuity of care can improve the quality of life. health outcomes by improving medical diagnoses, data-driven treatment decisions, digital therapeutics, clinical trials, self-management, and people-centered care, as well as expanding the evidence-based knowledge, skills, and competencies of practitioners to deliver health services [69] [70].

In the digital health agenda of Ecuador,[71] [72]it has been established as Strategy No. 2.- Strengthen the digital ecosystem to contribute to the quality of health care, one of its lines of action is: Promote the digital transformation of the computer systems of public and private health providers to improve the health care of the population. In this context, efficiency in the supply chain of medicines will be promoted, a priority issue for the country and one that will require a joint effort of the digital ecosystem in various segments of the process.

Supply chain of vaccines

The vaccine supply chain in Ecuador, involves several stages: programming, purchasing, storage, distribution, application, and monitoring.

1. **Requirement:** This involves planning for the types and quantities of vaccines needed based on the population's health needs and the country's immunisation goals.

2. **Purchasing:** Ecuador negotiates vaccination purchases directly from vaccine manufacturers to secure the lowest possible prices [73].

3. **Storage:** Vaccines are stored in a temperature-controlled supply chain, also known as the cold chain. This begins with the cold storage unit at the manufacturing plant and extends to the transport and delivery of the vaccine and proper storage at the provider facility. The cold chain ends with the administration of the vaccine to the patient. Manufacturers, distributors, public health staff, and healthcare providers share responsibility to ensure the vaccine cold chain is maintained from the time vaccines are manufactured until they are administered [74].

4. **Distribution:** The vaccines are distributed to health services from the national to the local level, following a set of rules and procedures that ensure their proper storage and distribution [75].

5. **Application:** Vaccines are administered to patients by healthcare providers.

6. **Monitoring:** After vaccination, the safety of vaccines is monitored through systems like the Vaccine Adverse Event Reporting System (VAERS), which is an early warning system that helps CDC and FDA monitor problems following vaccination. Anyone can report suspected vaccine reactions and issues to VAERS [3]. In addition, there are IoT-based solutions designed to monitor and track vaccines in real-time [76].

It's important to note that all these stages are interconnected and any disruption in one stage can impact the entire chain. Therefore, it's crucial to have clearly written, detailed, and up-to-date storage and handling standard operating

[69] Global Strategy on Digital Health 2020-2025. (2021). World Health Organisation.
[70] Mehl, G., Tunçalp, Ö., Ratanaprayul, N., Tamrat, T., Barreix, M., Lowrance, D., Bartolomeos, K., Say, L., Kostanjsek, N., Jakob, R., Grove, J., Bernardo, M., & Swaminathan, S. (2021). WHO SMART Guidelines: Optimising Country-level use of guideline recommendations in the Digital Age. The Lancet Digital Health, 3(4), e213-e216. https://doi.org/10.1016/s2589-7500(21)00038-8
[71] Agenda de Transformación Digital del Ecuador 2022-2025 Ministerio de Telecomunicaciones y Sociedad de la Información – Gobierno de Ecuador
[72] Agenda Digital de Salud 2023 – 2027 Ministerio de Salud Pública – Gobierno de Ecuador.
[73] https://www.oecd.org/coronavirus/policy-responses/using-trade-to-fight-covid-19-manufacturing-and-distributing-vaccines- dc0d37fc/
[74] https://www.cdc.gov/vaccines/hcp/admin/storage/toolkit/storage-handling-toolkit.pdf
[75] Biswas, K., Muthukkumarasamy, V., Bai, G., & Chowdhury, M. J. M. (2023). A reliable vaccine tracking and monitoring system for health clinics using blockchain. Scientific Reports, 13(1). https://doi.org/10.1038/s41598-022-26029-w
[76] Hugo, H., Michel, J., Antón, C., Alemán, W. R., Cueva, C., Bort, C., Andino, F., Edaki, O., Shrestha, P. S., Rodó, L., Ishak, A., Quinonez, J., Maskey, U., Ozair, S., Choudhari, J., Poudel, S., Jaiswal, V., Au, Z., Siddiqui, U., . . . Rodríguez-Morales, A. J. (2022). Usefulness of electoral models for COVID-19 vaccine distribution. Current Tropical Medicine Reports, 9(2), 61-71. https://doi.org/10.1007/s40475-022-00251-y

procedures (SOPs) that are reviewed by all staff [77].

Regulatory framework and related policies in Ecuador

Regulatory Framework

1. The Constitution of the Republic of Ecuador establishes that "All persons, individually or collectively, have the right to universal access to information and communication technologies (...)"[78] It also recognises health as a right guaranteed by the State, through economic, social, cultural, educational, and environmental policies.

2. The Organic Law on Health establishes that: "Every person, without discrimination for any reason, has the right to "have a single medical record written in precise, understandable and complete terms; as well as confidentiality with respect to the information contained therein (...)" [79]

3. The same regulation establishes that: "The national health authority, with the participation of the members of the National Health System, shall implement the common information system in order to know the health situation, identify the risks to people and the environment, size the available resources and the production of services, to guide political and managerial decisions and articulate citizen participation at all levels. among others." [80]

4. The Organic Law on Telecommunications establishes the competences of the Governing Body of Telecommunications and the Information Society, "To formulate, direct, guide and coordinate policies, plans and projects for the promotion of information and communication technologies and the development of telecommunications, as well as to supervise and evaluate their compliance" [81]

5. The Organic Law on the Protection of Personal Data, establishes with respect to the principle of confidentiality, that "(...)The processing of personal data must be conceived on the basis of due secrecy and secrecy, that is, it must not be processed or communicated for a purpose other than that for which they were collected, unless one of the causes that enable a new processing according to the cases of legitimate processing indicated in this law (...)" (4)

6. In addition, the regulation establishes that "(...) Data controllers and processors, as well as all persons involved in any phase of the data, shall be subject to the duty of confidentiality, in such a way as to ensure adequate security of personal data, including protection against unauthorised or unlawful processing and against its loss, destruction, accidental damage, through the implementation of appropriate technical and organizational measures. This obligation shall be supplementary to professional secrecy on a case-by-case basis. (...)" (4)

7. The Regulations to the Organic Law on Telecommunications define the Information Society as "(...) the one that uses and appropriates telecommunications and ICTs to improve quality of life, competitiveness and economic growth." (5)

8. The Model of Comprehensive Community and Intercultural Family Health Care (MAIS-FCI), issued through Ministerial Agreement No. 00000725, is the regulatory framework applicable throughout the National Health System

[77] Cold chain - PAHO/WHO | Pan American Health Organisation. (s. f.). https://www.paho.org/en/immunization/cold-chain
[78] Asamblea Nacional Constituyente de Ecuador. Constitución de la República del Ecuador [Internet]. 2008. 2021 [cited 2022 Apr 19]. Available from: https://www.telecomunicaciones.gob.ec/wp-content/uploads/downloads/2016/05/Ley- Org%C3%A1nica-de-Telecomunicaciones.pdf
[79] Gobierno de la República del Ecuador. Ley Orgánica de Salud / Reforma 2015 [Internet]. Registro Oficial Suplemento 423 de 22- dic.-2006. 2015. Available from: https://www.salud.gob.ec/wp-content/uploads/2017/03/LEY- ORG%C3%81NICA-DE-SALUD4.pdf
[80] Asamblea Nacional de la República del Ecuador. Ley Orgánica de Protección de Datos Personales [Internet]. 2021 [cited 2022 Jul 15]. Available from: https:// www.consejodecomunicacion.gob.ec/wp-content/uploads/downloads/2021/07/ lotaip/Ley Org%C3%A1nica de Protec-ci%C3%B3n de Datos Personales.pdf
[81] Presidencia de la República del Ecuador. Reglamento a la Ley Orgánica de Telecomunicaciones [Internet]. 2018 [cited 2022 Jul 15]. Available from: https://www.gobiernoelectronico.gob.ec/wp-content/uploads/2018/10/Reglamento-General-a-la-Ley-Org%C3%A1nica-de-Telecomunicaciones.pdf

(SNS), with respect to Integrity in the National Health System, states that: "(...) The integration of the health units at the three levels of care should result in continuous care for users through a network with appropriate organisation and technology, hierarchical to provide rationalised care to patients, according to the degree of medical and technological complexity of the problem and its treatment."[82]

9. The Ministerial Agreement 00002687 approves the Automated Daily Registry of Consultations and Ambulatory Attention RDACAA.

10. Ministerial Agreement No. 0009, the Regulations for the Management of Electronic Medical Records are approved, to define the guidelines for its application in health service provider establishments throughout the national territory.

11. Ministerial Agreement No. 00115, the Regulation for the Management of the Single Medical Record (HCU) is approved, which aims to regulate the content of the same and the requirements for its application by health professionals in the health establishments of the National Health System.

12. Ministerial Agreement No. 00083, approving the Ten-Year Health Plan 2022 – 2031, states that (...) the National Health Authority identified digital transformation as a critical axis for the improvement of the management of the sector (...)".[83]

Policies related to Ecuador

Digital health services represent a valuable tool to overcome barriers to access to health services, as they allow promotion, prevention, recovery, rehabilitation, and palliative care, especially in rural and dispersed areas where the capacity to solve problems is limited.

In order to guarantee the provision of health services and their quality, in **2008** the Ministry of Public Health began to intervene in the field of Telemedicine/Telehealth in the provinces of Morona Santiago, Pastaza and Napo, expanding through a pilot project at the national level starting in 2010.

Additionally, in Ecuador in **2013**, the Automated Daily Registration System for Outpatient Consultations and Care – RDACAA was implemented, which was updated and improved in **2016** with the purpose of strengthening the data registration for the health information system in the public ambulatory medical care registry, with expansion of use to the institutions of the Comprehensive Public Health Network.

In **2017**, the Health Care Registration Platform (PRAS) was developed and implemented, whose objective is the logical and orderly recording of data collected during health care and storage in the Electronic Medical Record, in response to the growing demand for public health care.

In this regard, Ministerial Agreements No. 1190 of **2011** and 0009 of **2017**, respectively, issued by the Ministry of Public Health, support the use of Health Level Seven (HL7), which is a set of standards to facilitate the electronic exchange of health information for implementation in all public institutions providing services of the National Health System; mainly in the management of the Single Electronic Medical Record and in the establishment of the Technical Table of Digital Agenda, with the aim of managing projects related to the records of the information systems that generate data, which constitute the legal framework for the strengthening and sustainability of the single health information system.

In this context and based on the beginnings of the digital transformation of health in Ecuador, starting in **2019**, the central level of the Ministry of Public Health generated a preliminary proposal for a Digital Health Agenda, with the support of the Inter-American Development Bank (IDB), for which construction and validation workshops were held in which delegates from the Ministry of Public Health participated. of the Comprehensive Public Health Network (RPIS), Complementary Private Network (RPC), among others.

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[82] Ministerio de Salud Pública del Ecuador. Manual del Modelo de Atención Integral de Salud - MAIS [Internet]. 2017 [cited 2022 Apr 19]. Available from: https://www.hgdc.gob.ec/images/DocumentosInstitucionales/Manual_MAIS MSP12.12.12.pdf
[83] Ministerio de Salud Pública - MSP. Acuerdo Ministerial Nro. 00083-2022 Expídese el Plan Decenal de Salud 2022-2031 [Internet]. [cited 2022 Jul 14]. Available from: http://esacc.corteconstitucional.gob.ec/storage/api/v1/10_DWL_FL

It is pertinent to mention that the implementation of the Digital Health Agenda responds to the purposes of the Ministry of Telecommunications and the Information Society, proposed in the document Digital Transformation Agenda of Ecuador 2022-2025", which refers as an objective *"To establish a coordinated multisectoral framework that establishes lines of action in relation to the country's digital transformation process, defining its governance and institutionality, and considering the transversality of ICTs"*.

Within this framework, the Digital Agenda of the health sector constitutes a public policy instrument for the conduction, articulation and promotion of the intensive use of Information and Communication Technologies (ICTs) in order to accelerate and sustain the process of digital transformation of the health sector with which it seeks to expand timely access. quality coverage, efficiency in the use of resources and financing processes and economic recognition.

04
CURRENT STATE ANALYSIS

Description of existing information systems in the vaccine supply chain

According to the interviews with the actors of the process, the activities carried out in each of the sub-processes were determined.

Requirement

The National Directorate of Immunisations is responsible for making the request based on information:

1. Population projections,
2. Vaccination coverage in the last year and
3. Stock of vaccines in the National Vaccine Bank.

The National Directorate of Statistics and Information Analysis of the National Health System is responsible for providing information for this purpose.

Once the demand by type of vaccine has been calculated, the National Directorate of Immunisations enters it into PAHO's VSSM software.

If any additional vaccine has to be included in the schedule, the National Directorate of Epidemiological Surveillance carries out the morbidity analysis, i.e. its participation is circumstantial.

The data are manual, they are prepared in an Excel sheet, and when the final quantities are available, they are typed into the OPS programming software.

Purchase

Based on budget availability, an issue discussed with the Ministry of Economy and Finance.

The Administrative Directorate is responsible for purchasing the requirement of vaccines and supplies based on the requirement made by the National Directorate of Immunisations.

The requirement document made by the National Directorate of Immunisations registered in the Quipux Document Management System, as well as in the Government Accounting System of the Ministry of Economy and Finance. The document we have is the contracting document.

Reception

This phase is the responsibility of both the Administrative Directorate as a whole and the National Directorate of Immunisations since they ensure the technical and safe reception of vaccines.

The entry of the vaccines is recorded in the Inventory Management System of the Administrative Directorate. And as a document we have the Inventory Management System report.

According to what was discussed with the actors of the Administrative Directorate, this system is a manual registration system, it does not interoperate with another system of registration of vaccination care.

Control and review

In this phase, the National Directorate of Immunisations controls and reviews the batches of vaccines that have arrived in the country. They review quantity, legality, stock, health registration and batches.

This step is recorded in the Inventory Management System of the Administrative Directorate. And as a document we have the Inventory Management System report.

Storage

In relation to the storage of the vaccines, they are carried out in cold chambers and other equipment according to availability, this process oversees the Administrative Directorate.

The characteristics of the storage are recorded in the Inventory Management System.

Zone Distribution

This step is also carried out by the Administrative Directorate, and distribution is carried out according to the requirement of the National Directorate of Immunisations and based on the availability of mobile units. The transfer is from the National Vaccine Bank to the Zones.

In the case of Ecuador, we have 9 zones, and it is subject to the availability of the mobilities that can be distributed. It should be noted that the mobile units are not only responsible for transporting vaccines, but also make a series of shipments to the different areas. So much so that one of the drawbacks is the delay in shipping, due to not having availability.

Another important point is the need to have traceability of the temperatures of the vaccines during transport. Until the arrival at the zonal coordination, it is registered in the inventory management system, and the vaccine movement report is available.

Distribution to the vaccination point

The stage of distribution of the vaccines to the vaccination point oversees the autonomous governments, that is, the zone coordinator must coordinate with the autonomous government. This instance must verify the availability of the mobile units for distribution to the area, district, or vaccination point.

Here, the managers are the zone coordinator, the district coordinator and the vaccination point coordinator. The report is manual and is the movement of the vaccine.

Vaccine Application

The vaccine is administered at the vaccination point once the vaccines and supplies have been received. The application is done by health professionals. This health care can be recorded in different PRAS systems. DHIS, 2 SIGOS and SAIZE. Likewise, the PRAS has an ofline module when there is no connectivity, from these systems you can report on the vaccination care carried out.

The lot code has to be entered manually; it does not interoperate with the Inventory Management System.

End user

In the case of the end user, once the vaccine has been applied, there may or may not be adverse effects to the application of the vaccine. If there are adverse effects to the application of the vaccine, these can also be recorded in one of the modules of the PRAS system. Likewise, if they do not show up, the vaccination is simply recorded as any other care, by the health professional and the vaccination certificate is provided.

05
KEY FINDINGS

Main problems identified

- In conclusion, considering that 100% of immunisations are carried out at the first level of care (95% in health facilities and 5% in campaigns in schools and others), including that of children with some pathology for which they are in the hospital, a reference is made to the first level of care to carry out the vaccination according to the hospital's request. The importance of the supply chain becomes more resonant, as all vaccines must be distributed to the last point of vaccination.

- In this sense, health information systems will allow us to notice the reality and be able to make decisions in a timely and appropriate manner.

- What we see is that health information systems don't interoperate, that is, they don't get to share data between administrative information in the supply chain and health care information. If we analyse the scheduling sub-process, it is manual, it does not automatically feedback from the data on the consumption of vaccines from the vaccinations that are carried out at the vaccination points. In this case, the National Directorate of Immunisations requests from the areas the reports of both vaccination coverage and stocks at a cut-off date. This information goes from each vaccination point to the coordination by area. These are manual records that are susceptible to error. From the central level, it is not possible to display the vaccine stocks by vaccination point from an information system.

Areas for improvement

- In the requirement, is possible to correct the population projections by analysing the data, considering that the total population is ascribed, and calculate the percentage of variability of the migrant population through the health establishment, which would allow a redistribution to be carried out, despite having the population assigned.

- In the same way, the greatest human resource that carries out the vaccination are rural nurses, who have a high turnover of personnel, the criteria for scheduling vaccines are diverse, to standardise them the National Directorate of Immunisations must carry out training and thus reduce the error of, for example, not scheduling a percentage of contingency vaccines.

    - Having consumption data and some additional scheduling criteria such as contingency and late vaccinations, could improve and refine the scheduling calculation. This factor can be calculated and introduce in the requirement and distribution, decreasing error and with it the shortages.

- In the case of the sub-processes from purchase to receipt, we have an inventory management system that is manual, each of the data must be recorded by each actor. When there is greater typing, there is greater susceptibility to error, and there is still no link between administrative information and health care information. Linking data from different subsectors allows for broader and deeper research in public health, which can lead to more efficient management of health and social programmes and policies.

- In the case of the PRAS system, it is possible to have the batch data, since it is requested to be recorded for each vial or dose given, however, as it is a data that exists and has already been registered, when requesting a new manual registration, it is susceptible to human error.

    - There is a need for automation and interoperate, register in several records that do not converse, it is

important that administrative information links with administrative information. In this sense, the diversity and population coverage of the linked data, along with the temporal stability and lower cost compared to primary data collection, are significant advantages that enhance public health research.

- In the hypothetical case of investigating a VAERS, where we must see the traceability of the cold chain at all stages since the vaccine arrived in the country, at this time it is not possible to do it automatically, but the information must be reconstructed manually, for example linking the batch of vaccine with the transfer unit and what temperatures they recorded at that time. Which in the case of vaccines is essential, which is why traceability and information security are essential.

- In the case of storage, the National Directorate of Epidemiological Surveillance pointed out the need to also strengthen the monitoring of the cold chain through a system of sensors, like thermohygometers, or another sensor, that automatically feed the temperature data of the vaccines in the central, zone, district, and health facility warehouses. Avoiding manual work overload for registration.

    - It is important that the system guarantees the traceability of vaccine data, as well as including georeferencing during transport to the different areas, districts, and health facilities.

- Another extremely important point is the transfer, although what has been stated by the National Directorate of Immunisations and corroborated by the Administrative Directorate is that there are no mobile units that are exclusively for the transfer of vaccines, but that they are at the mercy of the availability and use of other instances of the Ministry of Health. This puts the supply opportunity at risk. They also do not have the traceability of temperature information and georeferencing of the routes of the mobile units. Since the distribution is divided between the distribution made by the central level to the zones and from the zones to the vaccination points it is available to the autonomous governments, then we lose the data on when the vaccines actually arrive and under what temperature conditions.

    - It is important to consider effective access to vaccines, which includes transportation, it is necessary to rethink what is the best option, whether a hiring of a company, or the purchase of vehicles that allow the vaccine to be available, and not prolong the deadlines.

- Likewise, the National Directorate of Epidemiological Surveillance, the need to develop an Operations Center that, based on an intelligent information system, allows the surveillance of vaccines at the national level and to see in real time the issuance of alerts to anticipate cold chain break events.

Inventory System of the supply chain of pharmaceutical products, medical devices, and health products

The management of the processes is manual, it requires 5500 workers per month to consolidate stock data, and the information is handled centrally, it implies errors and inefficiencies. Stocks are not online; data becomes crucial for decision-making in time and supply. The information reaches the area, it does not reach the district or health facility, a distribution can reach up to 3 months, for example.

- **Stage I:** The system already has the homologation of catalogs, parameterisation of users, registration of income and expenses,

- **Stage II:** Dec 2023 This system must be for the entire RPIS and must be connected to the MEF's government accounting system, to avoid entry into several similar records, because currently a consolidation Excel is also registered in the MEF Inventory System (eSBYE), and at least as 5 entries and have delays of 3 to 4 months in the entry of information due to the large operational load.

- **Stage III:** 2024 The system must have integration with medical units so that they feed other care processes with electronic medical prescription, demand planning, automation of formats, scheduling of providers, specialised formatting.

5.1.1.
It is a scalable system that allows interoperability with PRAS and other related registries, avoiding operational burden and registry errors.

5.1.2. Needs:

- They can't hire developers for more than $1600 per month with face- to-face work, when the market pays $2300 for hybrid work.
- Hybrid trainings, they cannot go to areas within the security triangle due to citizen security crises.
- There is a lack of funding for PDA readers, for printing barcodes for pharmaceuticals and medical devices.
- The development of digital warehouse management is lacking.
- They don't have online stocks, and consumptions are based on history, not actual consumption.
- It does not have an operations center for managing the supply chain of pharmaceuticals and medical devices, including transportation to zones.

According to what we discussed with the Management of Innovation and Technological Transformation in Health, it informed us that Ecuador was in the implementation of Phase I of the Inventory System of the supply chain of pharmaceutical products, medical devices, and health products. As vaccines are considered medicines, they are also included in this project. The system will allow for the traceability of medicines during the phases of the supply chain and can be linked to care data.

Considering that vaccination is carried out at the first level of care, and that the PRAS system houses all the information of the first level of care, this system would interoperate with the PRAS system. When asked about this, the manager mentioned that in later phases, since the PRAS must have several updates that allow information to be shared in a modular way.

On this path to achieving interoperability, it is necessary to overcome technical challenges, such as the standardisation of data formats and the adoption of common protocols for the exchange of information. Ecuador is on this path; it has adopted the HL7 – FHIR standards that guarantee interoperability.

Likewise, legal, and ethical frameworks are also required to ensure the protection of the privacy and security of personal data. In this regard, Ecuador, with Executive Decree No. 1014 since 2008, established the use of free software in their computer systems as a public policy for central public administration entities. Free software is understood to mean that computer programmes can be used and distributed without any restrictions, that allow access to the source codes and that their applications can be improved. Likewise, it has defined a digital agenda for the country and the Ministry of Public Health has defined a digital health agenda, steps that point to the death and construction of health data governance.

Relevant examples or case studies

Technology plays a crucial role in improving the vaccine supply chain by enhancing efficiency, transparency, and reliability. Here are some ways in which technology is utilised:

Blockchain Technology: Blockchain technology ensures transparency and trust among stakeholders in the vaccine supply chain. It provides an enhanced level of security, transparency, and traceability of stored vaccines,

[84] Hu, H., Xu, J., Liu, M., & Lim, M. K. (2023c). Vaccine Supply Chain Management: an intelligent system utilising blockchain, IoT and machine learning. Journal of Business Research, 156, 113480. https://doi.org/10.1016/j.jbusres.2022.113480
[85] Yadav, A. K., Shweta, & Kumar, D. (2023). Blockchain Technology and vaccine Supply Chain: Exploration and analysis of the adoption barriers in the Indian context. International Journal of Production Economics, 255, 108716. https://doi.org/10.1016/j.ijpe.2022.108716

enabling the complete history of every vaccine to be checked from the day the vaccine is received [84]. Blockchain technology integrated with the Internet of Things (IoT) can create a solution for global vaccine distributions with improved trust and transparency [85].

Internet of Things (IoT): IoT enables real-time monitoring of vaccine status, ensuring vaccine quality [1]. An IoT-based real-time data- centric monitoring system for the vaccine cold chain has been proposed, which can help in tracking and monitoring the temperature of vaccines during storage and transportation [86].

Machine Learning and Artificial Intelligence: Machine learning and artificial intelligence can be used to model the vaccine supply chain as a dynamic system, helping in demand forecasting and managing inventory levels [87].

Digital Technologies: Digital technologies can support the deployment of vaccines and set the groundwork for a new era of supply chain management. They can leverage digital tools to improve communication, reduce latency, increase agility to respond to disruptions, and improve visibility [88].

Temperature Monitoring Systems: Temperature monitoring systems, such as continuous monitoring and recording digital data loggers (DDL), are recommended for maintaining the cold chain for vaccines. These systems can monitor the temperature of vaccines 24/7, ensuring that they are stored under the right conditions [89].

5.1.3. Data Management Systems:

Data management systems, such as UNICEF's RT-VaMA tool, provide real-time data on vaccine rollouts, improving vaccine distribution [90].

In summary, the use of technology in the vaccine supply chain can lead to improved efficiency, transparency, and reliability, ultimately leading to better vaccine distribution and administration.

[86] Goodson, J. L., & Rota, P. A. (2022). Innovations in vaccine delivery: increasing access, coverage, and equity and lessons learnt from measles and rubella elimination. Drug Delivery and Translational Research, 12(5), 959-967. https://doi.org/10.1007/s13346-022-01130- 9
[87] Martin, J., & Martin, J. (2022, 13 diciembre). The supply chain innovations behind the world's largest vaccine programme. Pharmaceutical Technology. https://www.pharmaceutical-technology.com/sponsored/the-supply-chain-innovations-behind-the- worlds-largest-vaccine-programme/
[88] Vaccine Development and Surveillance | Gates Foundation. (s. f.). Bill & Melinda Gates Foundation. https://www.gatesfoundation.org/our-work/programs/global-health/vaccine-development-and-surveillance
[89] Vaccine Development and Surveillance | Gates Foundation. (s. f.). Bill & Melinda Gates Foundation. https://www.gatesfoundation.org/our-work/programs/global-health/vaccine-development-and-surveillance
[90] Tavana, M., Shaabani, A., Vanani, I. R., & Gangadhari, R. K. (2022). A review of Digital Transformation on supply chain process management using text mining. Processes, 10(5), 842. https://doi.org/10.3390/pr10050842

06 CONCLUSIONS

The main conclusions that can be drawn from the document are as follows:

6.1.
Specific areas in Ecuador with low vaccination coverage include the provinces of Morona Santiago, Sucumbíos, and Guayas. These areas face challenges related to geographical access, communication and education, and socioeconomic factors.

6.2.
The Ministry of Public Health of Ecuador has implemented measures to improve vaccination coverage in these areas, including improving accessibility, education, and communication, and implementing specific vaccination campaigns.

6.3.
The digital transformation in the health sector in Ecuador includes the implementation of health information systems, which allow for the collection, management, and analysis of health data.

6.4.
Strategies to improve healthcare in rural and remote areas include promoting regional cooperation in the provision of digital healthcare solutions and strengthening local capacity to respond to public health emergencies.

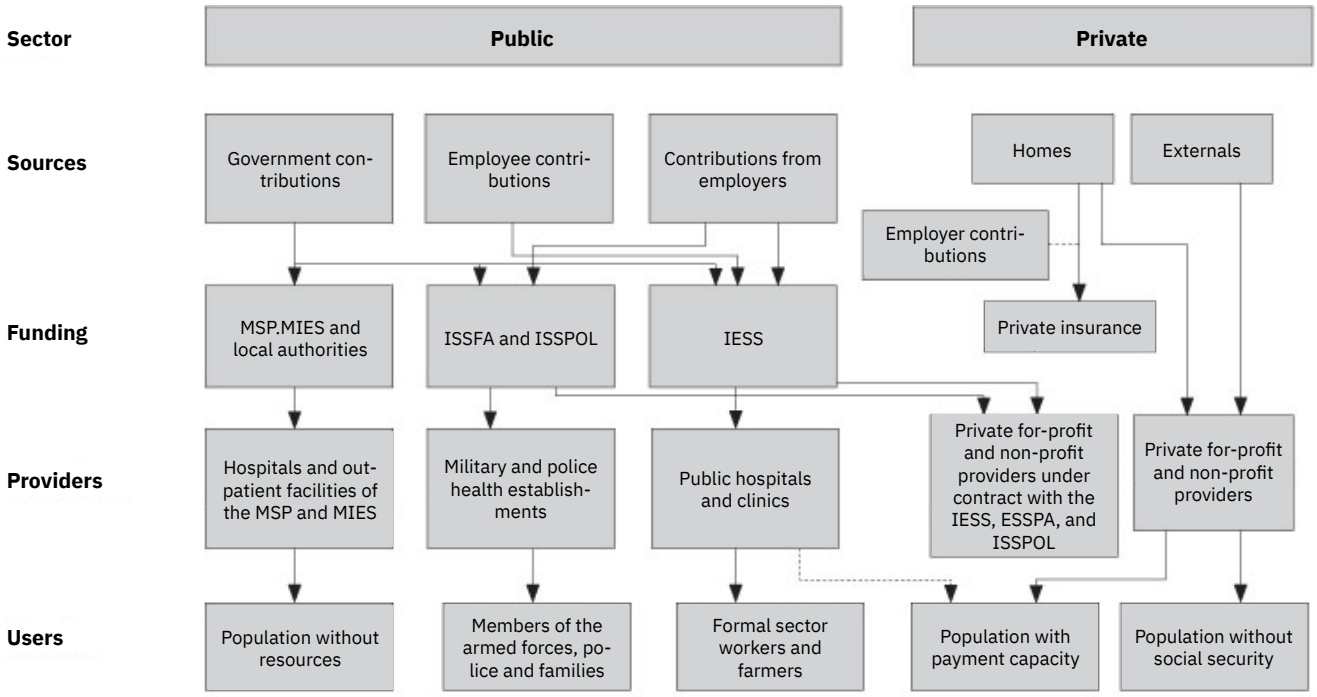
6.5.
The implementation of health information systems and digital technologies in Ecuador faces challenges related to interoperability, data privacy and security, and the need to adapt to local conditions and the needs of rural and remote populations.

6.6.
In summary, Ecuador has made significant efforts to improve vaccination coverage and healthcare in rural and remote areas, as well as to advance digital transformation in the health sector. However, there are still challenges to address gaps in vaccination coverage and ensure equity in access to quality healthcare for all populations.

07
ANNEXES

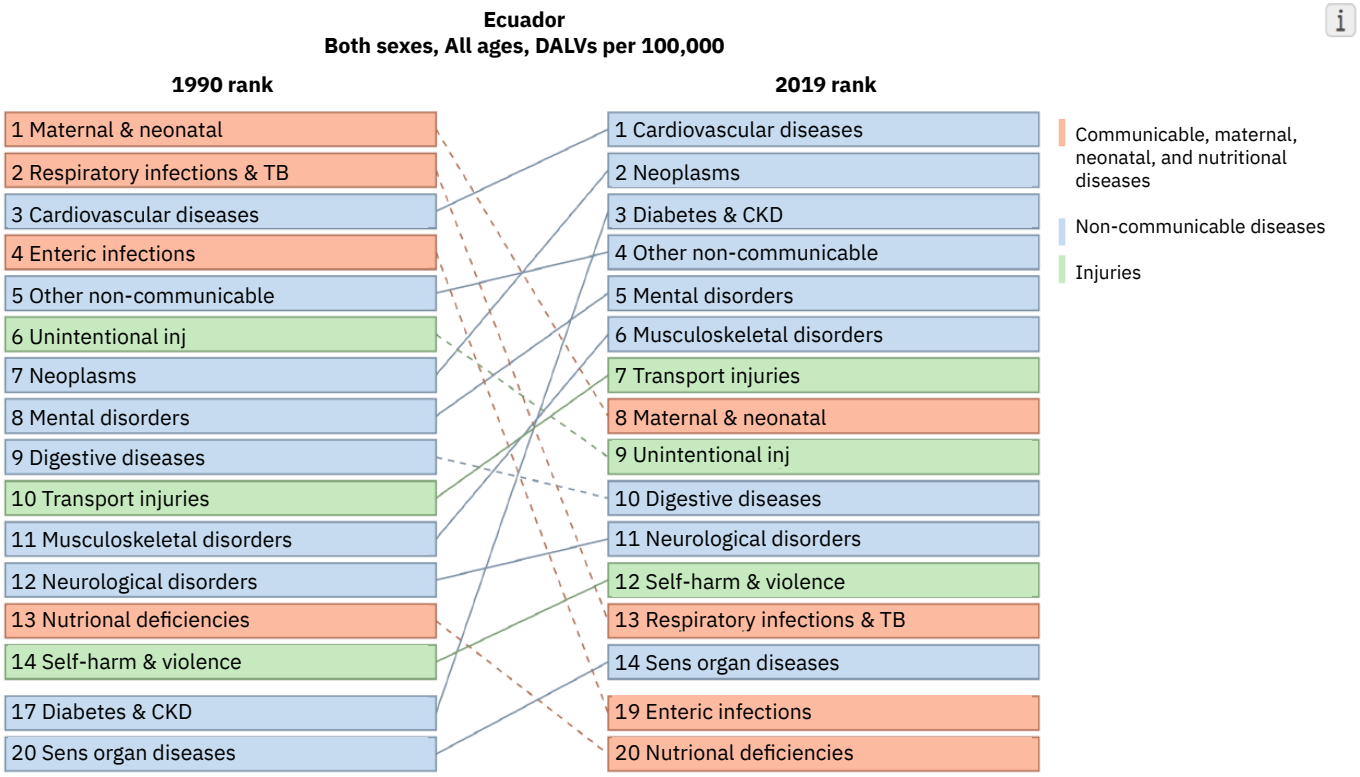
Supporting, charts, tables

Figure N° 01 Outline of the Health system in Ecuador



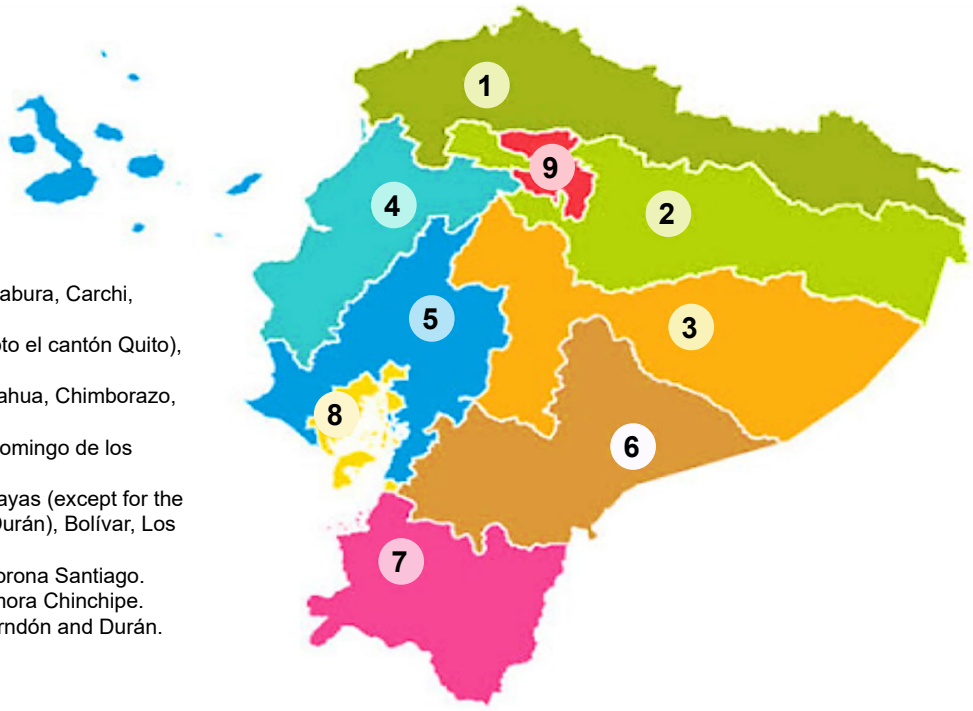
Source: Lucio, R. (s. f.). Sistema de Salud de Ecuador. **Recuperate from:** http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0036-36342011000800013

Figure N° 02 Comparative diagram of disease burden Ecuador 1990 vs Ecuador 2019



Source: GBD compare. (s. f.). **Recuperate from:** https://vizhub.healthdata.org/gbd-compare/

Figure N° 03 Map of Ecuador's Planning Zones

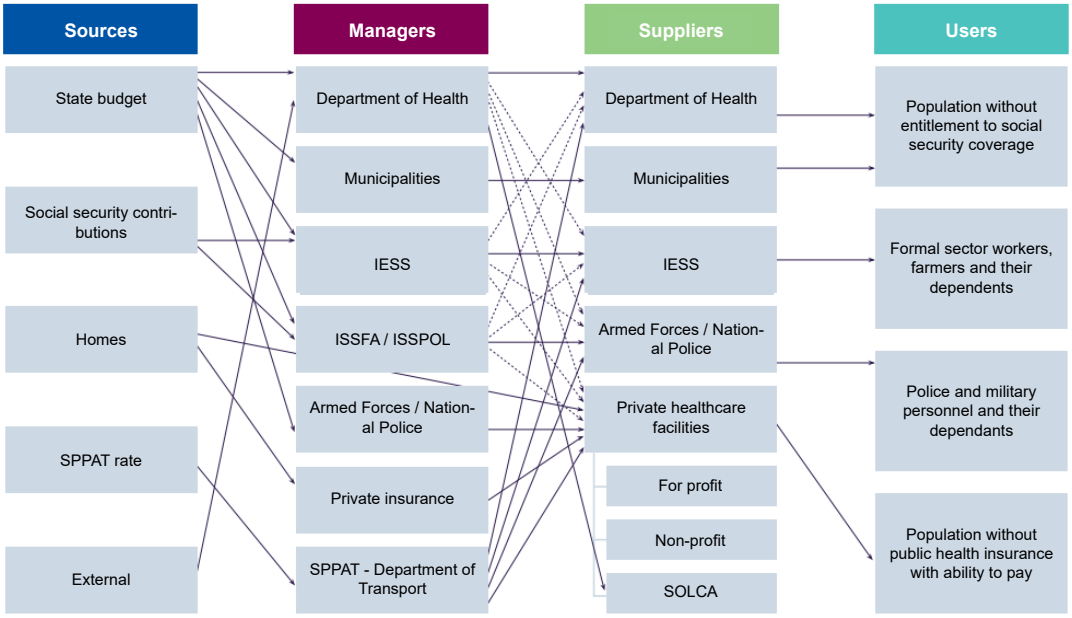


Zone 1: Provinces of: Esmeraldas, Imbabura, Carchi, Sucumbios.
Zone 2: Provinces of: Pichincha (excepto el cantón Quito), Napo, Orellana.
Zone 3: Provinces of Cotopaxi, Tungurahua, Chimborazo, Pastaza.
Zone 4: Provinces of: Manabí, Santo Domingo de los Tsáchilas.
Zone 5: Provinces of: Santa Elena, Guayas (except for the districts of Guayaquil Samborondóny, Durán), Bolívar, Los Ríos and Galápagos.
Zone 6: Provinces of: Cañar, Azuay, Morona Santiago.
Zone 7: Provinces of: El Oro, Loja, Zamora Chinchipe.
Zone 8: Districts of: Guayaquil, Samborndón and Durán.
Zone 9: Metropolitan District of Quito

Source: colaboradores de Wikipedia. (2023, 2 noviembre). Organización Territorial de Ecuador. **Recuperate from:** https://es.wikipedia.org/wiki/Organizaci%C3%B3n_territorial_de_Ecuador

Figure N° 04 Financing model of the Ecuadorian Health System

Illustration 1: Financing model of the Ecuadorian Health System



Source: Financing of the Ecuadorian National Health System for universal coverage. (2021, august 25). https://www.ilo.org/sites/default/files/2024-08/wcms_817788.pdf

Figure N° 05 Health Indicators and Health Financing in Latin America

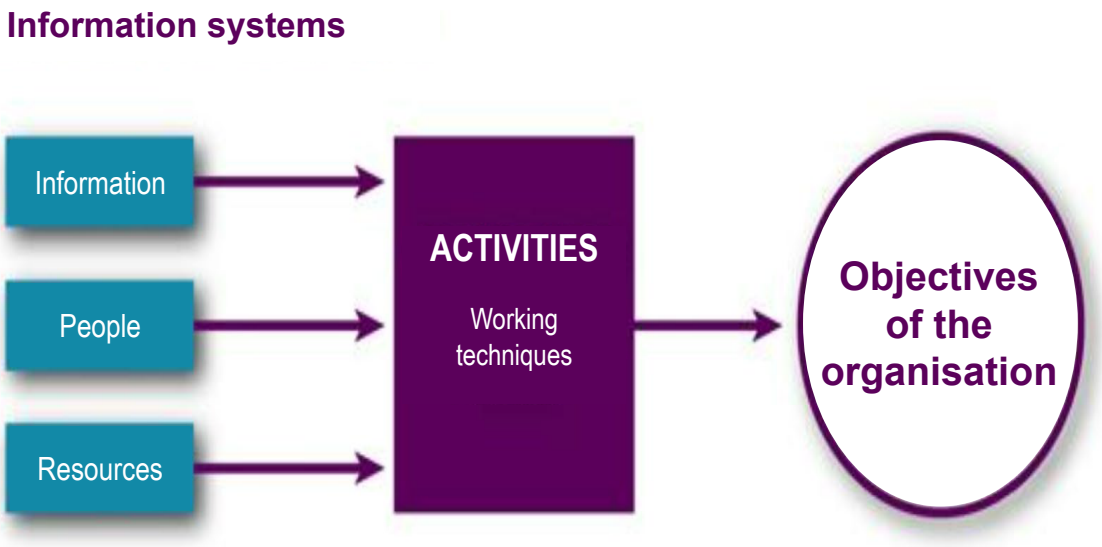
Table 1: Health indicators and health financing in Latin America

	Population (thousands)	Health expenditure (2018)			Health indicators (latest year available)					
		Total health expenditure (millions PPP)	Total health expenditure %GDP	Per capita expenditure on health (PPP)	Population (thousands)	Reported maternal mortality ratio (per 100,000 LB)	Reported infant mortality rate (per 1,000 LB)	Reported neonatal mortality rate (per 1,000 LB)	Age-adjusted overall mortality rate per 100,000 inhabitants.	x Children under 5 years of age with growth retardation
Argentina	44361	88263	9,6	1990	76,9	33,7	9,7	6,5	5,9	
Bolivia	11353	5632	6,3	496	69,8	160,0	24,0	15,0		
Brasil	209469	320660	9,5	1531	75,9	64,4	14,0	9,6	6,1	
Chile	18729	43183	9,1	2306	79,9	9,0	7,0	5,2	4,6	1,8
Colombia	49661	57379	7,6	1155	74,7	53,7	17,1	7,0	6,3	12,7
Ecuador	17084	16312	8,1	955	76,8	39,7	9,1	5,2	5,5	23,9
Paraguay	6956	6506	6,7	935	73,3	86,4	13,7	9,5	6,6	5,6
Peru	31989	24524	5,2	767	75,5	69,8	15,0	10,0	6,1	13,1
Uruguay	3449	7482	9,2	2169	77,8	18,6	6,5	4,3	5,6	10,7
Venezuela	28887	11078	3,6	384	74,9	82,1	15,2	11,1		

PPP: Purchasing power parity
LB: Live births

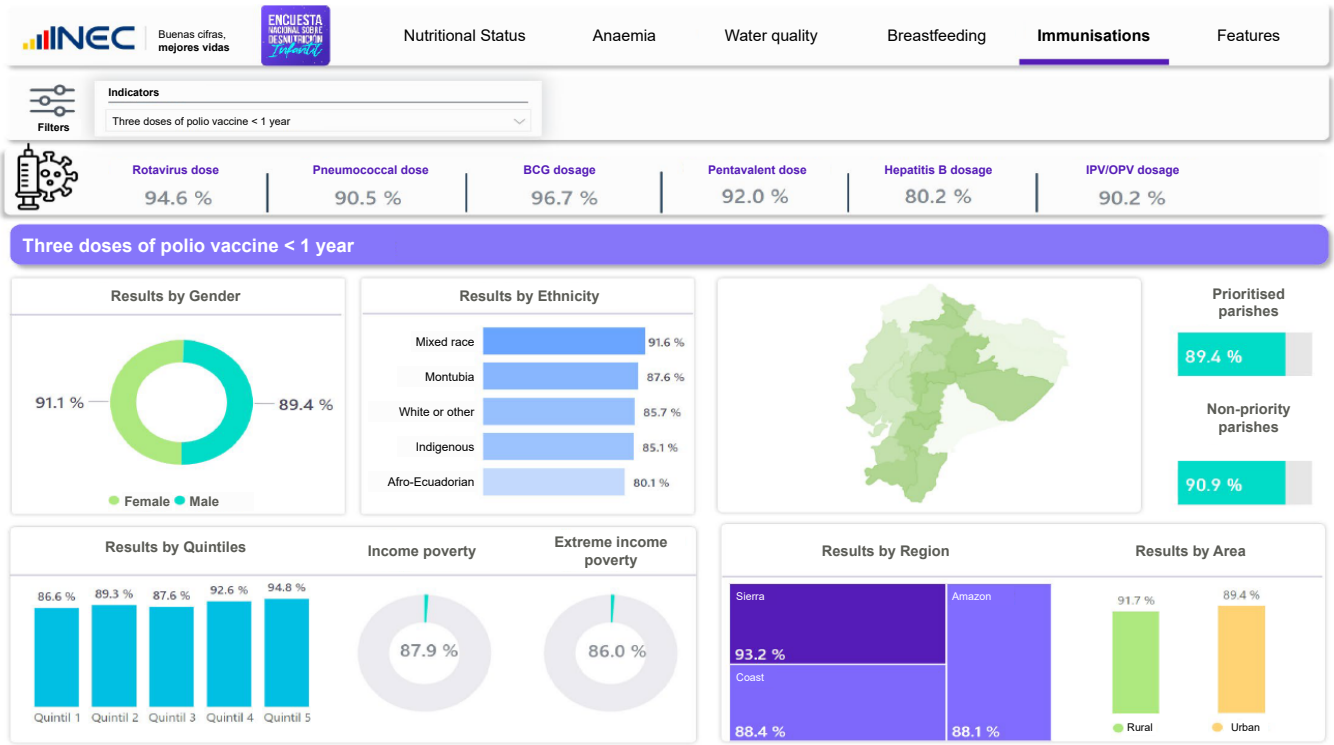
Source: Financing of the Ecuadorian National Health System for universal coverage. (2021, august 25). https://www.ilo.org/sites/default/files/2024-08/wcms_817788.pdf

Figure N° 06 Shaping of information system



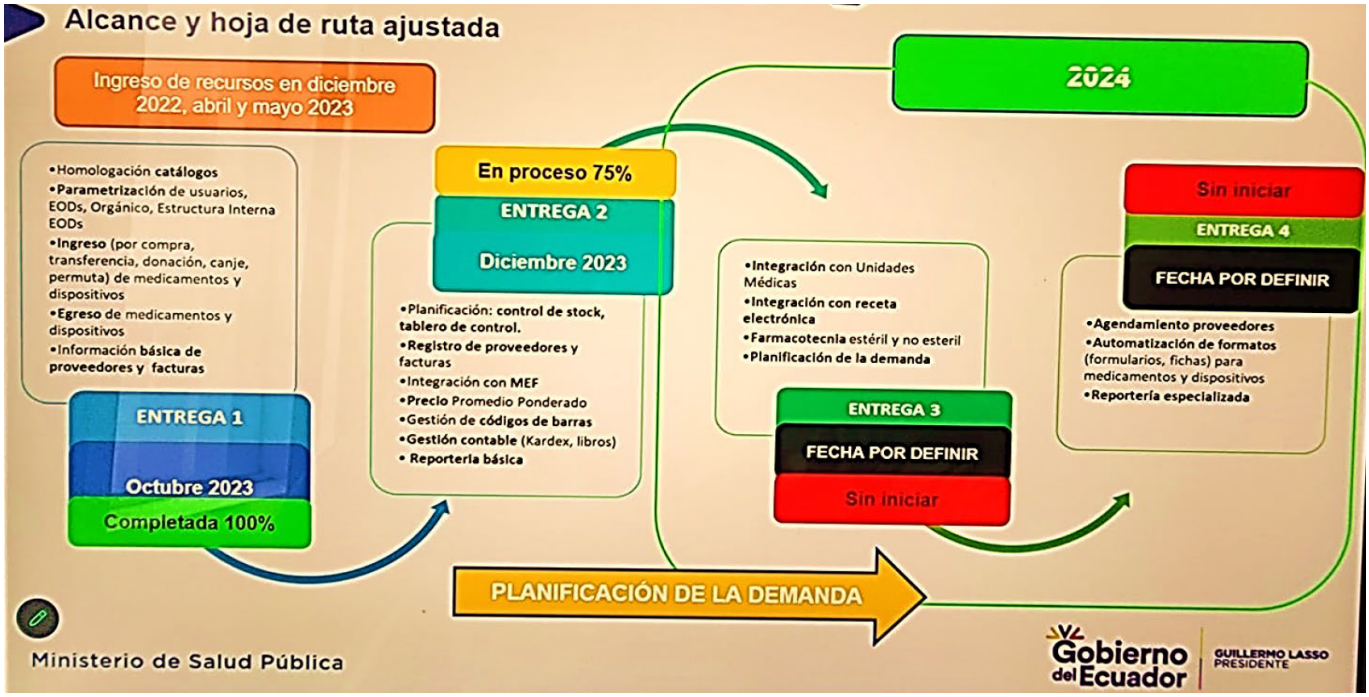
Source: Luna, D., Otero, C., Plazzotta, F., & Campos, F. (2018). Sistemas de Información para la Salud (1.a ed.). Fernán González Bernaldo de Quirós. ISBN 978-987-46479-3-1

Figure N° 07 Immunisation Indicator in the Specialised Survey on Child Malnutrition



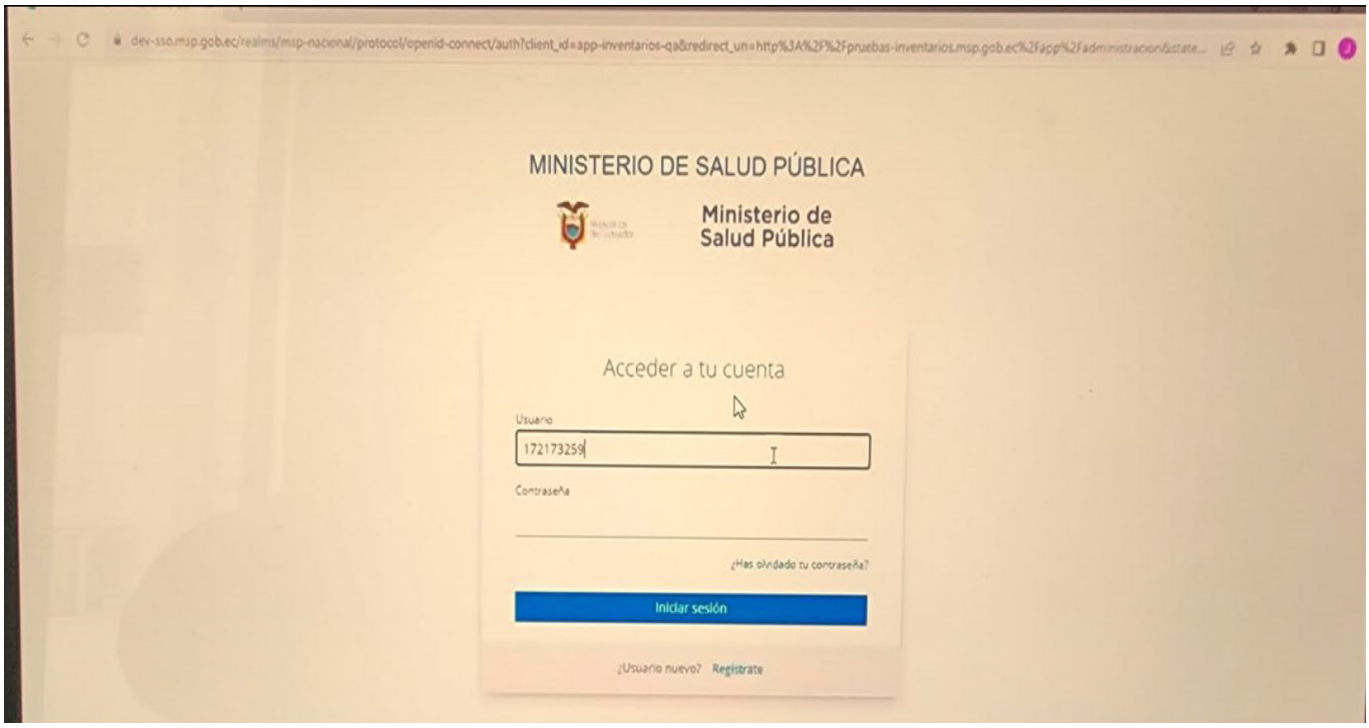
Source: 1ra. Encuesta Especializada sobre Desnutrición Infantil (ENDI) available from:https://app.powerbi.com/view?r=eyJrIjoiNzBjZWM0ZmItNzY2YS00ZWEyLTg3NTctMzgyZDA1M2I1ODAxIiwidCI6ImYxNT hhMmU4LWN-hZWMtNDQwNi1iMGFiLWY1ZTI1OWJkYTExMiJ9

Figure N° 08 Scope and Roadmap –
Inventory System for the supply chain of pharmaceuticals and medical devices.



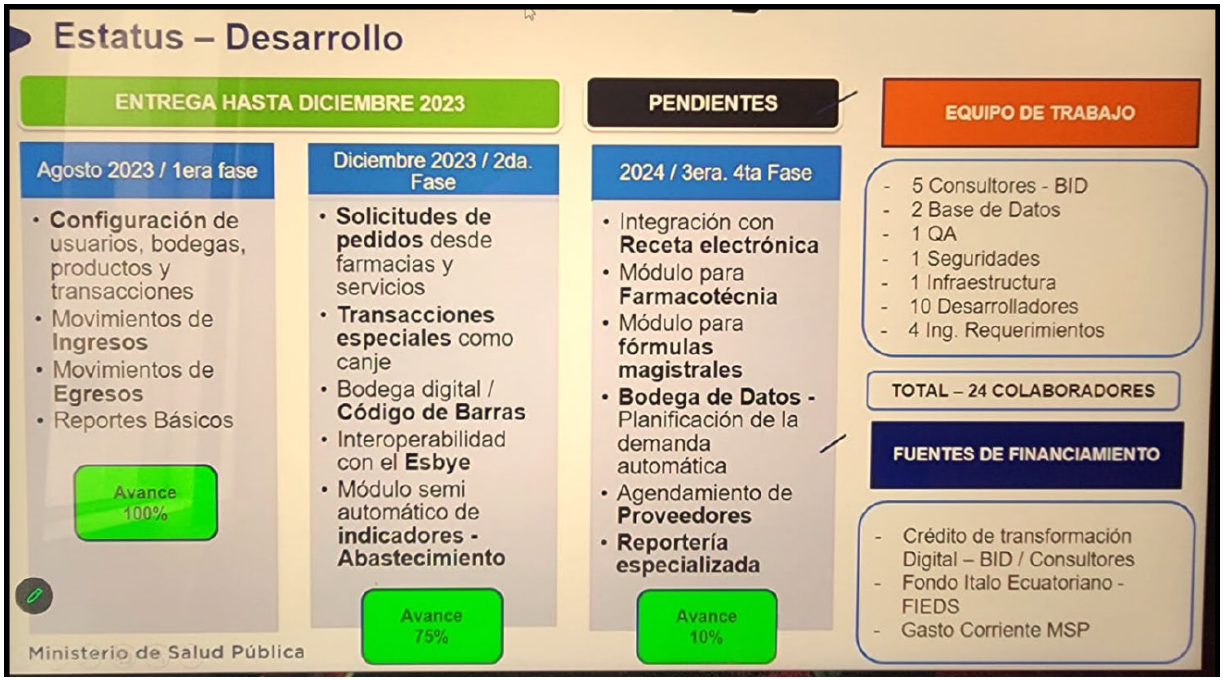
Source: Task Force Delegate presentation during the interview 24.10.2023

Figure N° 09 Access to Inventory System for the supply chain of pharmaceuticals medical devices.



Source: Task Force Delegate presentation during the interview 24.10.2023

Figure N° 10 Access to the Inventory System for the supply chain of pharmaceuticals and medical devices - Development Status



Source: Task Force Delegate presentation during the interview 24.10.2023

Figure N° 11 Access to the Inventory System for the supply chain of pharmaceuticals and medical devices - Implementation Status

Source: Task Force Delegate presentation during the interview 24.10.2023

Figure N° 12: Improvement Projects of the supply chain of pharmaceuticals and medical devices

Source: Task Force Delegate presentation during the interview 24.10.2023

Figure N° 13: Situational Status of the pharmaceuticals and medical devices Warehouse's

Source: Task Force Delegate presentation during the interview 24.10.2023

Interviews or surveys conducted

https://1drv.ms/f/s!AlDRilrSyEtyibEqP4377JsOKmXoIA?e=9hmZdA

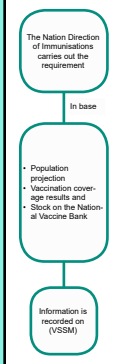
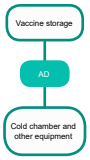
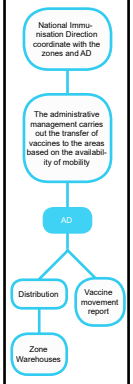
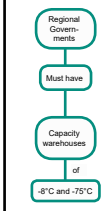
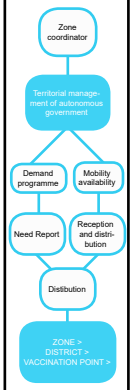
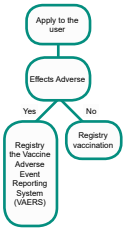
Mis archivos > COOPERACION ALEMANA > Entrevistas

Nombre	Modificado	Fecha de cap...	Tamaño de arc...	Uso compartido
Zoom Meeting 2023-10-24 11-58-15.mp4	Ayer a las 19:45:19	Ayer a las 19:45:19	30.9 MB	Compartido
Zoom Meeting 2023-10-24 11-59-50.mp4	Ayer a las 19:45:25	Ayer a las 19:45:25	59.2 MB	Compartido
Zoom Meeting 2023-10-24 11-58-34.mp4	Ayer a las 19:45:31	Ayer a las 19:45:31	99.9 MB	Compartido
Zoom Meeting 2023-10-24 11-53-57.mp4	Ayer a las 19:45:48	Ayer a las 19:45:48	58.4 MB	Compartido
Zoom Meeting 2023-10-24 11-51-14.mp4	Ayer a las 19:46:00	Ayer a las 19:46:00	9.43 MB	Compartido
Zoom Meeting 2023-10-24 11-54-51.mp4	Ayer a las 19:46:43	Ayer a las 19:46:43	420 MB	Compartido
Zoom Meeting 2023-10-24 11-51-26.mp4	Ayer a las 19:47:02	Ayer a las 19:47:02	302 MB	Compartido
Zoom Meeting 2023-10-24 11-46-53.mp4	Ayer a las 19:48:29	Ayer a las 19:48:29	533 MB	Compartido
Zoom Meeting 2023-10-24 11-42-52.mp4	Ayer a las 19:49:22	Ayer a las 19:49:22	434 MB	Compartido
Screen Sharing Meeting Controls 2023-10-...	Ayer a las 19:49:40	Ayer a las 19:49:40	72.5 MB	Compartido

Product Presentation

https://bit.ly/49IksOb

Supply Chain Flow Diagrams

	Requirement	Purchase	Reception	Control and Review	Storage	Distribution to Zone	Reception in Zone warehouses	Distribution to Vaccination point	Aplication	Final User
General Process										
MSP										
Responsible	• National Immunisation Direction • National Institute of Statistics of Ecuador • National Direction of Epide-miological Surveillance	• Administrative Direction • Ministry of Economic and Finance (MEF)	• Administrative Direction • National Immunisation Direction	• Administrative Direction • National Immunisation Direction	• Administrative Direction	• Administrative Direction	• Zone coordinator • Administrative Direction	• Zone coordinator • Distrital coordinator • Vaccination point coordinator	• Health professional	• Health professional
Software	• Hoja de Excel • Vaccine and Syinge Stock Management (VSSM)	• Quipux - Document Manage-ment System • Government accounting system (MEF)	• Inventory management system	• Inventory management system	• Inventory management system	• Inventory management system	• Manual Report	• Manual Report	• PRAS • DHIS2 • SIGOS • SARE	• PRAS • Digital Card
Documents	• Estimation of demand based on population	• Hiring File	• Central warehouse inventory report	• Central warehouse inventory report	• Central warehouse inventory report	• Central warehouse inventory report • Vaccine movement report	• Vaccine movement report	• Vaccine movement report	• System Report	• System Report

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