KERALA.HEALTH

A Report on

Kerala Health & Family Welfare and

K-DISC – Emerging technology initiatives in Health sector

(Pilot Innovations and Public Sector Transformation by K-DISC)

[2018-2026]

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Executive Summary

The healthcare sector in Kerala is undergoing rapid transformation driven by increasing disease burden, rising healthcare demands, growing patient expectations, and the need for efficient, technology-enabled service delivery. While Kerala has achieved notable progress in healthcare outcomes, public health systems continue to face challenges related to accessibility, workforce constraints, fragmented workflows, delayed diagnostics, interoperability limitations, and increasing operational complexity. Addressing these challenges requires innovative, scalable, and contextually relevant solutions to strengthen healthcare delivery and improve citizen experience.

Recognizing this need, the Emerging Technology (ET) Division of the Kerala Development and Innovation Strategic Council (K-DISC) has undertaken multiple initiatives to facilitate the adoption of emerging technologies within the healthcare sector. Through a problem-driven and collaborative approach, K-DISC works with government departments, healthcare institutions, research organizations, startups, and technology partners to conceptualize, pilot, validate, and scale innovative healthcare interventions suited to Kerala's public health ecosystem. The division emphasizes pilot-based implementation to assess technical feasibility, operational suitability, stakeholder acceptance, and scalability.

This report presents an overview of healthcare-focused emerging technology initiatives undertaken by K-DISC during 2018–2026, spanning domains such as Artificial Intelligence (AI), Blockchain, Internet of Things (IoT), Robotics, predictive analytics, digital health integration, and intelligent automation. These interventions address challenges across areas including blood management, immunization, diagnostics, rehabilitation, respiratory care, digital health services, patient navigation, and healthcare coordination.

Several initiatives have demonstrated operational feasibility and public-sector relevance. Key interventions include the statewide implementation of the Blood Bag Traceability System across 89 blood centres, deployment of a beneficiary mobile application and web portal for KASP-PMJAY, and implementation of Immunochain, a blockchain-enabled vaccine traceability platform supporting immunization workflow digitization and beneficiary tracking. Other initiatives such as G-Gaiter for robotic rehabilitation and AI-based diagnostic systems, further demonstrate the potential of emerging technologies to strengthen clinical workflows, care coordination, and healthcare efficiency.

The experiences documented in this report indicate that emerging technologies can strengthen public healthcare systems when implemented through structured, evidence-based, and

collaborative approaches. The learnings from these initiatives provide a foundation for building a more integrated, citizen-centric, and technology-enabled healthcare ecosystem in Kerala

CHAPTER 1. INTRODUCTION

1. About K-DISC Emerging Technologies Division

1.1. Kerala Development and Innovation Strategic Council

The Kerala Development and Innovation Strategic Council (K-DISC) is the strategic think tank and advisory body to the Government of Kerala, established to foster innovation-led development and facilitate evidence-based policymaking across sectors. K-DISC functions as a key institutional mechanism to support the State in identifying emerging challenges, evaluating future opportunities, and promoting the adoption of innovative approaches for sustainable and inclusive development.

The core mandate of K-DISC is to formulate and drive plans that reflect the latest advancements in technology, products, and process innovations to support the holistic development of Kerala. By facilitating interdisciplinary collaboration and promoting knowledge-driven governance, K-DISC seeks to strengthen the State's capacity to respond proactively to evolving socio-economic and technological challenges.

Recognizing the transformative role of innovation in governance and public service delivery, K-DISC works towards creating a robust ecosystem that enables the effective translation of ideas into implementable solutions. The organization collaborates with government departments, public institutions, research organizations, industry stakeholders, startups, and domain experts to conceptualize, validate, and operationalize innovative interventions across priority sectors.

K-DISC's interventions span multiple thematic domains including healthcare, agriculture, education, environment, digital governance, disaster resilience, and emerging technologies. Through strategic advisory support, pilot implementations, and ecosystem facilitation, K-DISC contributes to improving institutional efficiency, strengthening citizen-centric service delivery, and fostering inclusive development outcomes.

In an increasingly technology-driven world, governments are required to continuously adapt to emerging opportunities while addressing growing systemic complexities. To support this transition, K-DISC has established specialized divisions that focus on accelerating emerging technology adoption across departments. The Emerging Technology Division plays a significant

role in identifying, evaluating, and facilitating the adoption of cutting-edge technological interventions within public systems.

1.2. Emerging Technologies Division

One of the key objectives of K-DISC is to encourage and facilitate the adoption of Emerging Technology solutions across various Departments and public agencies under the Government of Kerala to improve the efficiency, effectiveness, and responsiveness of public systems and processes.

The rapid advancement of digital technologies has created unprecedented opportunities for transforming governance, public service delivery, and institutional decision-making. Technologies that were previously limited to research laboratories or private-sector innovation ecosystems are increasingly demonstrating practical relevance in addressing real-world public challenges. However, the successful integration of such technologies within government systems requires structured experimentation, contextual adaptation, stakeholder alignment, and evidence-based validation.

In response to this evolving landscape, the Emerging Technology (ET) Division of K-DISC functions as a dedicated institutional mechanism to support government departments in exploring, piloting, and operationalizing emerging technologies in a systematic and responsible manner.

The division focuses on facilitating the adoption of technologies including, but not limited to:

- Artificial Intelligence (AI) and Machine Learning (ML)
- Blockchain Technologies
- Internet of Things (IoT)
- Robotics and Intelligent Automation
- Robotic Process Automation (RPA)
- Big Data Analytics
- Augmented Reality (AR) and Virtual Reality (VR)

The ET Division adopts a problem-driven rather than technology-driven approach, wherein interventions are conceptualized based on clearly identified challenges faced by government departments and public institutions. Instead of promoting technology adoption in isolation, the division seeks to identify practical, scalable, and contextually relevant solutions capable of generating measurable improvements in public systems.

The division functions as a facilitator between government departments, technology startups, research institutions, academic organizations, implementation partners, and subject matter experts. By enabling collaborative innovation and pilot-based validation, the ET Division supports departments in reducing implementation risks associated with technology adoption while strengthening institutional confidence in emerging solutions.

Given the diversity of government operations and sector-specific requirements, technology interventions often require careful customization, iterative testing, and phased implementation. The division therefore emphasizes pilot-driven implementation strategies to evaluate technical feasibility, operational suitability, stakeholder acceptance, and scalability potential prior to wider deployment.

1.3. Project Life Cycle of Emerging Technology Interventions

The Emerging Technology Division follows a well-defined and transparent project management framework to ensure systematic execution, accountability, and evidence-informed implementation of projects. The life cycle of emerging technology interventions typically involves the following stages:

1. Project Ideation

Projects are conceptualized based on identified challenges or opportunities within government departments and public systems. This stage involves stakeholder consultations, requirement identification, preliminary problem assessment, and exploration of technology suitability.

2. Project Proposal Approval by Department

Following initial consultations and feasibility discussions, detailed project proposals are developed and submitted to the concerned Department for approval. This stage includes defining objectives, scope, implementation methodology, expected outcomes, and resource requirements.

3. Technology Partner (Startup) Identification

Suitable technology partners, including startups and solution providers, are identified based on technical capabilities, domain expertise, innovation potential, and alignment with project requirements through Kerala Startup Mission. The process prioritizes emerging innovation ecosystems and encourages startup participation in public-sector problem-solving.

4. Financial Approval and Registration

Following technical and administrative approvals, necessary financial sanctions and procedural clearances are obtained to initiate project implementation in accordance with applicable

governance and financial frameworks. All projects are reviewed and approved by the Technical Committee chaired by the IT Secretary, Government of Kerala.

5. Project Implementation

Projects are deployed through pilot implementations, proof-of-concept demonstrations, or controlled operational environments. During this phase, stakeholder coordination, technical integration, monitoring, and iterative refinement are undertaken by K-DISC to ensure effective implementation.

6. Benefit Evaluation and Project Completion

Upon pilot completion, interventions undergo benefit evaluation to assess operational effectiveness, feasibility, user acceptance, efficiency improvements, and broader implementation potential. The findings from this stage help departments take informed decisions regarding project closure, further refinement, or scale-up.

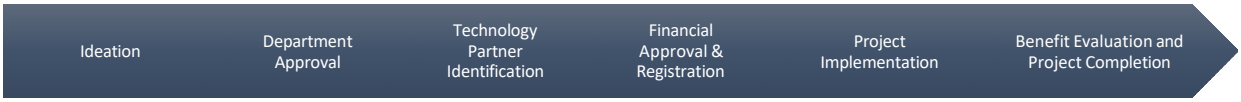

Figure 1: Project Life Cycle

Following successful pilot implementation and benefit evaluation, projects are formally handed over to the respective end-user departments. Based on observed outcomes and institutional requirements, departments may choose to scale the intervention across the State, expand implementation through a Phase-II pilot, or integrate additional functionalities to maximize benefits for both administrative systems and citizens.

1.4. Sectoral Engagement of the Emerging Technology Division

The Emerging Technology (ET) Division of K-DISC engages with multiple government departments and public institutions across diverse sectors to facilitate the adoption of innovative and emerging technology solutions for addressing systemic challenges and improving service delivery.

Recognizing that governance challenges vary across domains, the division adopts a context-sensitive and problem-driven approach wherein interventions are conceptualized and implemented based on the unique requirements of each sector. The nature and scale of engagement may therefore differ depending on institutional priorities, operational complexity, technology readiness, and implementation feasibility.

Over time, the ET Division has supported initiatives spanning multiple sectors including healthcare, agriculture, education, governance, sustainability, mobility, disaster resilience, and public administration. These engagements range from early-stage problem identification and technology scouting to pilot implementation, proof-of-concept validation, stakeholder coordination, and scale-up facilitation.

Through these engagements, the ET Division supports the identification, evaluation, and pilot-based validation of emerging technology solutions to address sector-specific challenges. By facilitating evidence-based experimentation and implementation assessment, K-DISC seeks to strengthen the Government of Kerala's capacity to leverage emerging technologies for improving institutional efficiency, enhancing service delivery, and promoting citizen-centric governance.

Among the sectors engaged by the ET Division, healthcare has emerged as a key area of strategic importance due to the increasing complexity of healthcare delivery systems, growing demand for accessible and efficient care, evolving disease burdens, and the transformative potential of emerging technologies in improving public health systems.

The healthcare sector presents unique opportunities for the application of technologies such as Artificial Intelligence (AI), Internet of Things (IoT), digital traceability systems, intelligent diagnostics, and workflow automation to address longstanding systemic challenges. At the same time, healthcare interventions require careful validation, stakeholder alignment, and pilot-driven implementation to ensure safety, reliability, operational feasibility, and sustainability.

In this context, the Emerging Technology Division has undertaken multiple healthcare-focused initiatives aimed at strengthening public health systems through technology-enabled innovation, collaborative implementation, and evidence-informed experimentation.

2. Healthcare Innovation Landscape in Kerala

2.1. Overview of Healthcare in Kerala

Kerala has long been recognized as one of India’s leading states in healthcare performance, supported by comparatively strong public health indicators, extensive healthcare infrastructure, and a long-standing emphasis on social development. The State has demonstrated significant achievements in areas such as life expectancy, maternal and child healthcare, literacy-driven health awareness, immunization coverage, and disease prevention.

The healthcare ecosystem in Kerala comprises an extensive network of public and private healthcare institutions, including medical colleges, district hospitals, taluk hospitals, community health centres, family health centres, and primary healthcare facilities that collectively contribute to healthcare accessibility across urban and rural areas. This network has enabled the State to

maintain relatively strong public health outcomes and demonstrate resilience in responding to health emergencies and disease outbreaks.

Kerala has also played a pioneering role in implementing public health reforms, strengthening decentralized healthcare systems, and adopting digital mechanisms to improve healthcare administration and service delivery. Investments in healthcare infrastructure, community health programs, and institutional strengthening have significantly contributed to improved health outcomes over the years.

However, the healthcare sector is undergoing rapid transformation driven by changing disease patterns, technological advancements, demographic shifts, and increasing citizen expectations regarding quality, accessibility, and responsiveness of healthcare services.

The growing prevalence of non-communicable diseases, increasing burden of chronic illnesses, ageing populations, rising demand for specialized healthcare services, and increasing complexity of clinical workflows are placing additional pressure on healthcare institutions and healthcare professionals. Simultaneously, healthcare systems are expected to improve efficiency, optimize resource utilization, strengthen patient safety, and enable faster and more informed decision-making.

These evolving dynamics have highlighted the need for innovation-driven approaches capable of strengthening healthcare systems while addressing operational, clinical, and administrative challenges.

2.2. Emerging Challenges in Healthcare Delivery

Despite significant achievements in healthcare, the sector continues to face multiple challenges that influence the efficiency, accessibility, and sustainability of healthcare delivery systems.

Healthcare institutions increasingly operate in complex environments characterized by high patient volumes, extensive data generation, specialized treatment requirements, and increasing demands for coordinated care delivery. Many healthcare processes continue to involve fragmented workflows, manual interventions, limited interoperability, and delayed information exchange, which may affect operational efficiency and decision-making.

In specialized domains such as oncology, emergency care, diagnostics, blood management, patient monitoring, and chronic disease management, healthcare systems often require enhanced technological capabilities to support accuracy, timeliness, traceability, and continuity of care.

Some of the emerging challenges influencing healthcare systems include:

- Rising burden of chronic and non-communicable diseases
- Increasing burden on healthcare workforce and specialists;
- Need for faster and more accurate clinical decision support;
- Limited availability of specialized expertise across locations;
- Requirement for improved traceability, monitoring and care coordination systems;
- Fragmented healthcare data and interoperability limitations;
- Need for real-time monitoring, early warning and predictive systems;
- Growing expectations for efficient, accessible, and citizen-centric healthcare delivery.

Addressing these challenges increasingly requires innovative approaches that combine healthcare expertise with technology-enabled solutions capable of strengthening institutional efficiency and service quality.

3. Portfolio of Health Initiatives by K-DISC

The table below presents an overview of healthcare initiatives undertaken by the Emerging Technology Division across different domains of intervention.

#	Initiative	Technology	Key Stakeholders
A	**State-Wide Implementation**		
1	Blood Bag Traceability	IoT	K-DISC, KSACS, H&FW Department, Bagmo Pvt Ltd, KELTRON
2	Mobile App to Connect the Beneficiaries of KASP-PMJAY Health Schemes	Mobile Application, Web Portal, API Integration	State Health Agency (SHA), Qkopy Online Services Pvt Ltd, eHealth Kerala, NHA
B	**Completed Projects**		
3	Immunochain	Blockchain,	K-DISC, Kerala Blockchain Academy, H&FW Department, FHC Kadakampally
4	Implementation of G-Gaiter - Gait Rehabilitator	Robotics, AI, VR	K-DISC, General Hospital TVM, H&FW Department, Genrobotic Innovations Pvt Ltd
5	AI Based System for Automatic Screening of Diabetic Retinopathy	AI/ML	K-DISC, DHS, C-DAC, eHealth Kerala

6	Antibiogram	AI	K-DISC, Government Medical College TVM, Department of Microbiology
7	Electronic Health Record Management Using Blockchain	Blockchain	K-DISC, eHealth Kerala, Kerala State IT Mission
8	Implementation of Hekaflo – IoT Enabled High Flow Nasal Oxygen Therapy Device	IoT	H&FW Department, Heka Medicals India Pvt Ltd, SAT Hospital, MCH Thrissur
9	Automated Cervical Cancer Screening using Artificial Intelligence	AI	SAT Hospital, MCC, Nex Fitzap Pvt Ltd (Logy.AI), VDNA Laboratories, Medprime
10	Wireless Infusion Monitor with Dripo at Malabar Cancer Centre	IoT	K-DISC, MCC, Dripo/Technology Partner
C	**Ongoing Projects**		
11	AI Based OP Token Slot Prediction System for Hospitals	AI/ML, Predictive Analytics	K-DISC, eHealth Kerala, Bagmo Pvt Ltd, MCH TVM, FHC Poozhanad
12	AI Chatbot for eHealth	AI, NLP, LLM	K-DISC, H&FW Department, eHealth Kerala, BzAnalytics Pvt Ltd
13	Kerala Bone Marrow Registry	AI/ML	H&FW Department, eHealth Kerala, MCC, WMDA
14	Integrated Healthcare Delivery System (IHCD)	Digital Health Integration, AI	K-DISC, H&FW Department, NHM, DHS, DME, eHealth Kerala, SDHM

Table 1: Portfolio of Health Initiatives by K-DISC

The subsequent chapters present detailed accounts of individual healthcare initiatives, including the underlying problem statements, technology interventions, implementation approaches, stakeholders, progress, observations, challenges, and future directions.

CHAPTER 2. STATE-WIDE IMPLEMENTATION PROJECTS

1. Blood Bag Traceability

1.1. Problem Statement

Blood transfusion is a critical life-saving service for managing medical emergencies, maternal hemorrhage, anemia, and trauma cases. In Kerala, blood availability across healthcare institutions is supported through a hub-and-spoke model comprising Blood Collection Centres (BCCs) and peripheral Blood Storage Centres (BSCs). However, ensuring the safe storage and transportation of blood bags remains a major operational challenge.

As per WHO guidelines, blood products such as whole blood and Packed Red Blood Cells (PRBCs) must be maintained within prescribed temperature ranges during storage and transport. However, the existing system had limited end-to-end visibility and traceability of blood bags during movement between BCCs and BSCs, increasing the risk of temperature deviations, delayed handling, inventory inefficiencies, and blood bag discard. These challenges directly affect blood availability, operational efficiency, and patient safety.

1.2. Existing Challenges

The blood storage and distribution system faced multiple operational challenges in ensuring the safe movement and availability of blood across healthcare institutions. A major challenge was the limited visibility and traceability of blood bags during transportation between Blood Collection Centres (BCCs) and Blood Storage Centres (BSCs), making it difficult to monitor storage conditions and handling during transit.

Maintaining the required temperature conditions during storage and transportation was another key challenge, as deviations could affect blood quality and lead to increased discard rates. In addition, the absence of real-time inventory visibility and coordinated stock monitoring across centres affected efficient blood utilization and timely availability during emergencies.

Further, limited access to updated blood stock information and lack of integrated monitoring mechanisms constrained coordination between BCCs and BSCs, affecting operational efficiency and reliability of blood transfusion services across the state.

1.3.K-DISC's Intervention

K-DISC conceptualized and implemented a pilot project to strengthen the traceability, monitoring, and management of blood bags within the public healthcare system. The intervention focused on introducing a digital blood bag traceability platform integrated with real-time temperature monitoring, automated alerts for temperature deviations, and inventory digitization to improve visibility across the blood supply chain. The system was designed to support end-to-end monitoring of blood bags during storage and transportation, strengthen coordination between Blood Collection Centres (BCCs) and Blood Storage Centres (BSCs), and improve transparency and accountability in blood bank operations

The pilot project was undertaken at General Hospital, Thiruvananthapuram and THQH Parassala to evaluate the feasibility of a technology-enabled blood traceability and inventory management system.

Based on success of the pilot implementation, the Department of Health & Family Welfare recommended statewide implementation of the system through the Kerala State AIDS Control Society (KSACS) and K-DISC

1.4. Recognitions Received for the project

1. **PMI Kerala Chapter Awards 2025**

   Category - **Project of the Year – Small**

2. **SILVER SKOCH Award 2025**

3. **SILVER AWARD - National eGovernance Awards 2026**

1.5. Technology Architecture and Key Functional Components

The project introduced multiple technology components to strengthen blood bag traceability, temperature monitoring and inventory visibility to blood availability information across the blood supply chain.

1. **Blood Bag Traceability Application:**

A centralized digital platform was developed to enable end-to-end tracking and monitoring of blood bags from donor collection to recipient transfusion. The application supports inventory

management, stock visibility, temperature monitoring, traceability, alert generation, and reporting across Blood Collection Centres (BCCs) and Blood Storage Centres (BSCs).

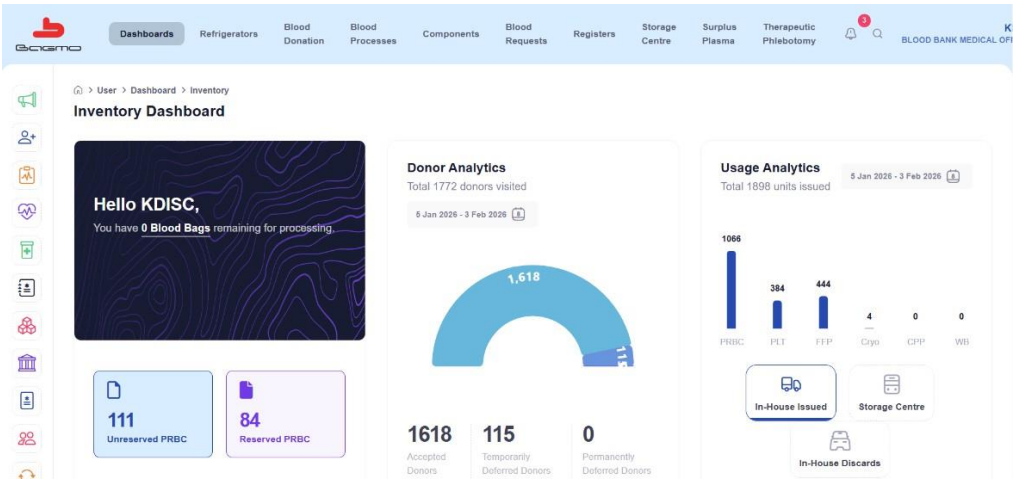

Figure 2:Blood Bag Traceability Application

2. Bagmo Blood Bag Traceability Device:

An IoT-enabled monitoring device was deployed to track the temperature and movement of blood bags during storage and transportation. The device supports monitoring of storage conditions, real-time data transmission, and automated alerts in the event of temperature deviations or handling-related issues.

Figure 3: Blood Bag Traceability Device

1.1. Stakeholders

#	Stakeholder	Role & Contribution

1	K-DISC	Led the pilot implementation, coordinated statewide project planning and execution, monitored implementation activities, and ensured technology integration and stakeholder coordination.
2	KSACS	Oversees statewide implementation, policy coordination, operational management, and monitoring of blood bank and storage centre integration.
3	Department of Health & Family Welfare (H&FW)	Provided administrative approval, policy guidance, audit recommendations, and strategic support for statewide rollout.
4	Bagmo Pvt Ltd	Technology Partner / Solution Provider. Developed and maintained the Blood Bag Traceability Application, Citizen Portal, and IoT-based monitoring devices and provided technical support.

Table 2: Stakeholders- Blood Bag Traceability

1.6. Pilot Location

The pilot implementation was carried out at the following healthcare institutions:

- General Hospital, Thiruvananthapuram – Functioned as the Blood Collection Centre (BCC) for blood collection, storage, and dispatch activities.
- Taluk Headquarters Hospital (THQH), Parassala, Thiruvananthapuram – Functioned as the Blood Storage Centre (BSC) for evaluating blood transportation, storage, and traceability mechanisms.

1.7. Outcomes / Observations

The pilot project demonstrated improvements in the traceability, monitoring, and management of blood bags across the blood storage and transportation lifecycle. The system enabled end-to-end traceability of blood bags from donor to recipient, strengthening transparency, accountability, and patient safety within blood transfusion services.

The intervention facilitated digitization of blood inventory management, reducing dependency on manual record-keeping and improving operational visibility across the pilot institutions. Real-time temperature monitoring at the Blood Collection Centre (BCC) and Blood Storage Centre (BSC) enabled continuous monitoring of storage conditions, while automated alerts supported timely corrective action in the event of temperature deviations. Periodic reporting functionalities also supported operational monitoring and decision-making.

A key outcome of the pilot was the improved monitoring and reduction of blood bag discard rates. Prior to implementation, the pilot recorded a discard rate of approximately 3.2% at the Blood Collection Centre (General Hospital, Thiruvananthapuram) and 53% at the Blood Storage Centre (THQH, Parassala). Following implementation of the digital traceability and monitoring system, a

noticeable reduction in discard percentage by 41% was observed at both pilot sites, indicating the potential of technology-enabled monitoring to improve blood utilization and reduce wastage.

Based on the positive outcomes observed during the pilot phase, the system was subsequently expanded to additional blood centres across Kerala, for which evaluation is currently underway.

1.8. Scale-Up Enhancements

As part of the statewide scale-up of the Blood Bag Traceability System, an additional citizen-centric digital platform named *Jeevadhaara* (https://jeevadhaara.kdisc.kerala.gov.in/) was implemented alongside the blood bag traceability devices and application to strengthen public access to blood availability information and voluntary blood donation services.

Citizen Portal – Jeevadhaara

Jeevadhaara is a public-facing digital portal launched by the Kerala State Blood Transfusion Council (KSBTC) with technical support from K-DISC to improve citizen participation in blood donation and facilitate easier access to blood availability information across the State.

The portal enables citizens to:

- Locate nearby blood banks and blood storage centres
- View real-time blood stock availability across institutions
- Respond to urgent blood requirements published by healthcare institutions
- Register and organize voluntary blood donation camps
- Access awareness resources related to blood donation

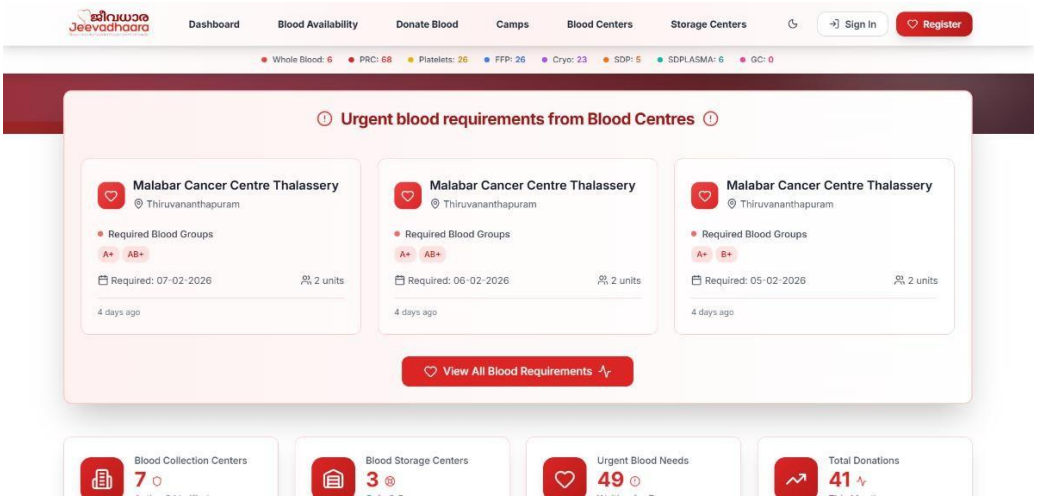

Figure 4:Jeevadhaara - Citizen Portal

By connecting citizens with blood banks and improving visibility of blood availability, the platform supports timely access to blood services, increased voluntary blood donation, and improved public engagement within the blood donation ecosystem.

1.9. Scale up locations

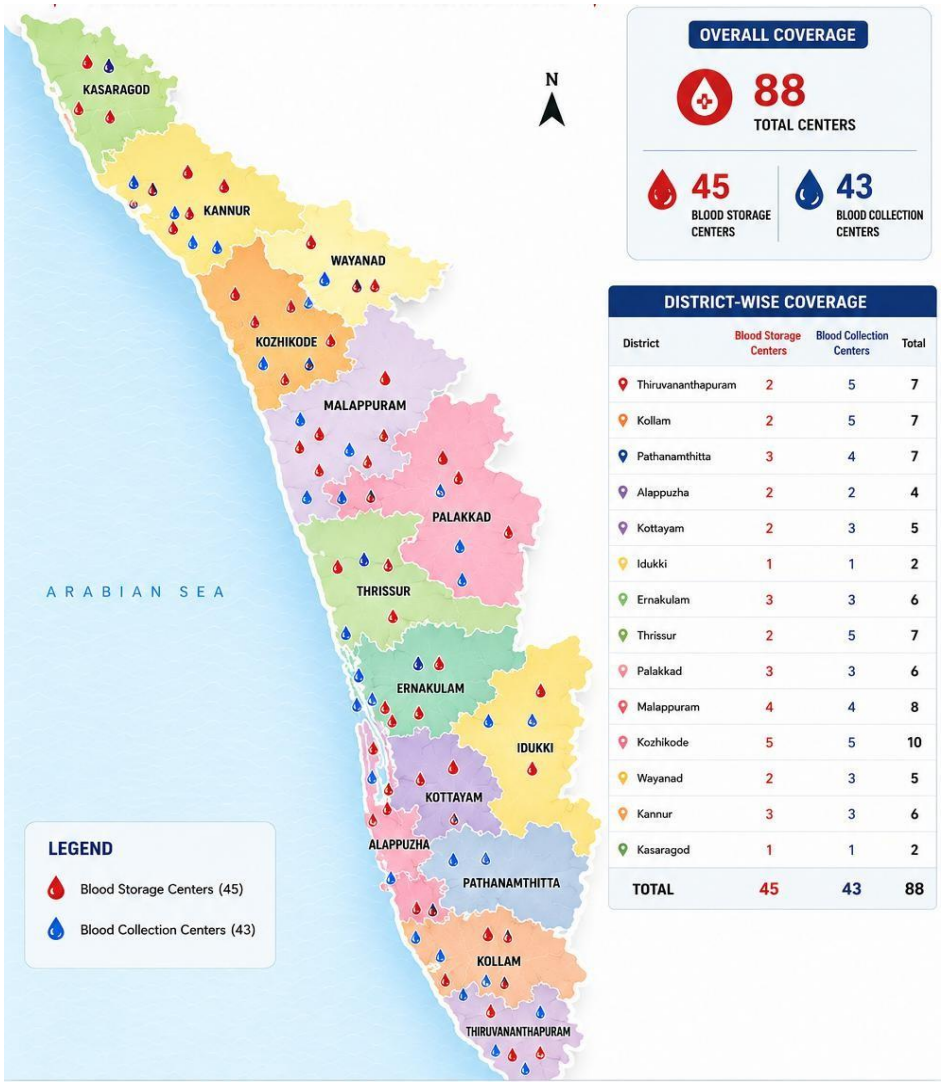

Figure 5: Span of Blood Centers across Kerala

#	Center Name	District	BSC/BCC
1	District Model Hospital Peroorkkada	Thiruvananthapuram	BSC
2	District Hospital Nedumangad	Thiruvananthapuram	BSC
3	General Hospital, Thiruvananthapuram	Thiruvananthapuram	BCC

4	Women and Children (W&C) Hospital, Thycaud	Thiruvananthapuram	BCC
5	General Hospital, Neyyatinkara	Thiruvananthapuram	BCC
6	THQH, Chirayinkeezhu	Thiruvananthapuram	BCC
7	Medical College, Tvm	Thiruvananthapuram	BCC
8	THQH, Parassala	Thiruvananthapuram	BSC
9	Government Medical College, Kollam	Kollam	BCC
10	THQH Kadakkal	Kollam	BSC
11	Taluk Hospital - Sasthamcottah	Kollam	BSC
12	THQH - Karunagappally	Kollam	BSC
13	District Hospital - Kollam	Kollam	BCC
14	THQH - Kottarakkara	Kollam	BCC
15	THQH - Punalur	Kollam	BCC
16	THQH - Tiruvalla	Pathanamthitta	BSC
17	THQH - Ranni	Pathanamthitta	BSC
18	District Hospital - Kozhencheri	Pathanamthitta	BSC
19	General Hospital - Pathanamthitta	Pathanamthitta	BCC
20	Government Medical College - Konni	Pathanamthitta	BCC
21	General Hospital - Adoor	Pathanamthitta	BSC
22	THQH - Kayamkulam	Alappuzha	BSC
23	District Hospital - Mavelikkara	Alappuzha	BCC
24	Women and Child Hospital, Alapuzha	Alappuzha	BCC
25	General Hospital - Alapuzha	Alappuzha	BCC
26	Government Medical College - Alleppy	Alappuzha	BCC
27	THQH Cherthala	Alappuzha	BSC
28	THQH Vaikom	Kottayam	BSC
29	General Hospital - Changanasseri	Kottayam	BSC

30	General Hospital - Kottayam	Kottayam	BCC
31	Government Medical College - Kottayam	Kottayam	BCC
32	Medical College Hospital - Kottayam	Kottayam	BSC
33	General Hospital - Pala (KM Mani Memorial)	Kottayam	BSC
34	THQH Peerumade	Idukki	BSC
35	Govt Medical College, Painavu	Idukki	BCC
36	District Hospital Aluva	Ernakulam	BCC
37	Govt Medical College, Kalamasserry	Ernakulam	BCC
38	General Hospital - Ernakulam	Ernakulam	BCC
39	General Hospital Muvattupuzha	Ernakulam	BSC
40	THQH Kothamangalam	Ernakulam	BSC
41	THQH North Paravur	Ernakulam	BSC
42	THQH Chavakkad	Thrissur	BSC
43	THQH Kunnamkulam	Thrissur	BSC
44	THQH Wadakkancherry	Thrissur	BSC
45	General Hospital Thrissur	Thrissur	BCC
46	Govt Medical College, Thrissur	Thrissur	BCC
47	THQH Chalakkudy	Thrissur	BSC
48	General Hospital Irinjalakkuda	Thrissur	BSC
49	THQH Kodungallur	Thrissur	BSC
50	Taluk Headquarters Hospital, Ottapalam, Palakkad	Palakkad	BCC
51	District Hospital, Sultanpett, Palakkad	Palakkad	BCC
52	Govt. Women and Child Hospital, Palakkad	Palakkad	BSC
53	THQH, Alathur, Palakkad	Palakkad	BSC
54	Taluk Headquarters Hospital, Mannarkkad	Palakkad	BCC
55	THQH CHITTUR, Palakkad	Palakkad	BSC

56	Taluk Tribal Speciality Hospital, Kottathara, Attapady	Palakkad	BSC
57	District Hospital Nilambur	Malappuram	BCC
58	TH, Wandoor	Malappuram	BSC
59	Medical College Hospital, Manjeri,	Malappuram	BCC
60	THQH - TIRURANGADI	Malappuram	BSC
61	District hospital Tirur	Malappuram	BCC
62	Taluk Hospital, Kuttipuram	Malappuram	BSC
63	Women & Children Hospital Ponnani	Malappuram	BSC
64	THQH,Kottapady Malappuram	Malappuram	BSC
65	District Hospital, Perinthalmanna	Malappuram	BCC
66	Govt. Women and Child Hospital, Kottaparamb	Kozhikode	BCC
67	Govt. General Hospital, Calicut	Kozhikode	BCC
68	Govt Medical college calicut	Kozhikode	BCC
69	Govt Medical college calicut	Kozhikode	BSC
70	THQH Thamarassery	Kozhikode	BSC
71	District Hospital Vadakara	Kozhikode	BCC
72	THQH Koyilandi	Kozhikode	BSC
73	THQH Kuttiady	Kozhikode	BSC
74	THQH Vythiri	Wayanad	BSC
75	General Hospital Kalpetta	Wayanad	BCC
76	CHC Meenangadi	Wayanad	BSC
77	THQH Sulthan Bathery	Wayanad	BCC
78	District Hospital Mananthavady	Wayanad	BCC
79	Malabar Cancer Centre Thalassery	Kannur	BCC
80	Taluk Hospital - Peravoor	Kannur	BSC
81	Taluk Hospital - Taliparamba	Kannur	BSC

82	Women & Children Hospital Mangattuparamba	Kannur	BSC
83	Govt Medical College, Pariyaram	Kannur	BCC
84	Taluk Hospital - Kuthuparamba	Kannur	BSC
85	District Hospital - Kannur	Kannur	BCC
86	General Hospital - Thalassery	Kannur	BCC
87	District Hospital, Kanhangad	Kasargod	BCC
88	General Hospital, Kasargod	Kasargod	BCC

Table 3: List of Blood Centers in Kerala

2. Mobile App to Connect the Beneficiaries of KASP-PMJAY Health Schemes

2.1 Problem Statement

Beneficiaries of the Karunya Arogya Suraksha Padhathi – Pradhan Mantri Jan Arogya Yojana (KASP-PMJAY) in Kerala faced challenges in accessing timely and accurate information related to their health insurance entitlements, including eligibility status, available balance amount, empanelled hospitals, and grievance support. In the absence of a centralized digital platform, beneficiaries primarily relied on hospital kiosks and call centres for obtaining information, resulting in inconvenience, delays, and limited awareness regarding scheme benefits. This highlighted the need for an accessible, beneficiary-centric digital solution to improve transparency, ease of access, and utilization of scheme-related services.

2.2 Existing Challenges

Prior to the intervention, KASP-PMJAY beneficiaries encountered several operational challenges in accessing health insurance-related information and support services.

The absence of a centralized beneficiary-facing digital platform limited public awareness regarding eligibility status, insurance coverage balance, empaneled healthcare institutions, and grievance redressal mechanisms. Beneficiaries often had to physically visit State Health Agency (SHA) kiosks located at hospitals or depend on the DISHA call centre to obtain essential information, resulting in inconvenience, delays, and additional travel-related expenditure.

The DISHA call centre, while functioning as an important support mechanism, was primarily limited to providing basic information and reportedly handled more than 2,000 beneficiary queries every month, indicating substantial demand for accessible and self-service information systems.

In addition to beneficiary-related challenges, administrative inefficiencies were also observed within the operational ecosystem. The State Health Agency (SHA) and empanelled hospitals relied on manual processes for generating monthly claims and performance reports, requiring considerable human effort and consuming nearly 500 man-hours each month. Such processes affected operational efficiency and limited timely access to analytical information required for effective monitoring and decision-making.

2.3 K-DISC's Intervention

Based on stakeholder consultations and a detailed understanding of the challenges faced by beneficiaries and the State Health Agency (SHA), K-DISC, in collaboration with relevant stakeholders, facilitated the development of digital solutions aimed at improving accessibility to scheme-related information and strengthening administrative efficiency within the KASP-PMJAY ecosystem.

The intervention comprised two key components:

1. **Beneficiary Mobile Application:**

A mobile application was developed to enable KASP-PMJAY beneficiaries to conveniently access essential scheme-related information, including eligibility status, available insurance balance, empanelled hospitals based on location and specialty, and other relevant beneficiary services. The platform was designed to improve accessibility, transparency, and ease of access to healthcare entitlement information.

2. **Administrative Web Portal:**

A web portal was developed to support the operational and monitoring requirements of the State Health Agency (SHA) and empanelled hospitals. The platform facilitates automated report generation, dashboard-based monitoring, and access to beneficiary and claims-related information to support administrative decision-making and scheme management.

2.4 Technology Architecture and Key Functional Components

The project incorporates multiple technology components designed to improve beneficiary access to scheme-related information while strengthening administrative monitoring and reporting capabilities of the State Health Agency (SHA).

The solution comprises a beneficiary-facing mobile application and an administrative web portal supported by centralized data management and reporting systems.

Beneficiary Mobile Application

The mobile application was developed to provide beneficiaries with convenient and real-time access to key scheme-related services and information. The platform enables users to:

a. Verify eligibility status under the scheme;
b. Check available insurance balance;
c. Search empaneled hospitals;
d. Access notifications and scheme-related updates; and
e. Utilize grievance support mechanisms.

By enabling direct access to healthcare entitlement information, the application seeks to reduce dependency on physical kiosks and telephonic support systems.

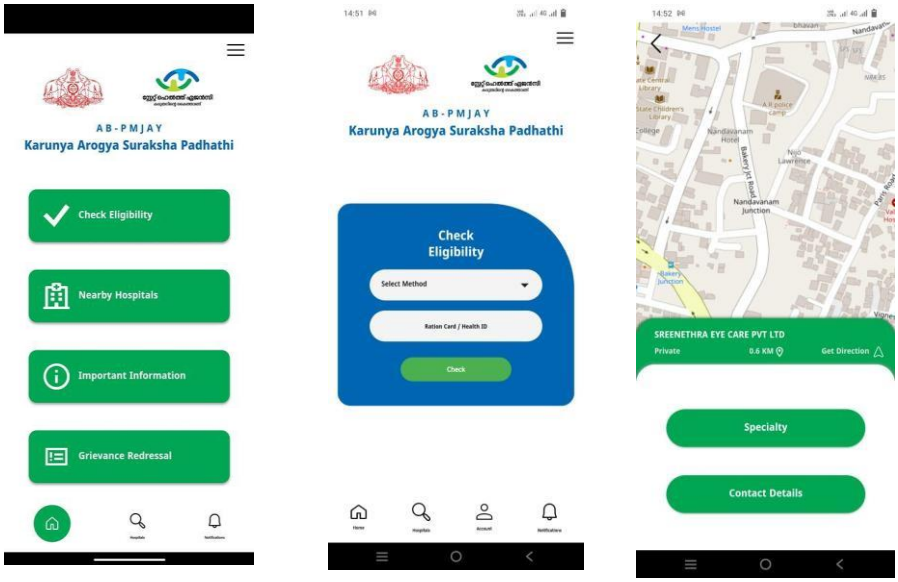

Figure 6: Mobile Application for KASP-PMJAY Beneficiaries

Administrative Web Portal

A dedicated web portal was developed to support the administrative requirements of the State Health Agency and empaneled hospitals. The portal facilitates:

a. Beneficiary verification
b. Claims and performance reporting
c. Sent important Alerts to Mobile app Users
d. User Management – For SHA and Hospitals

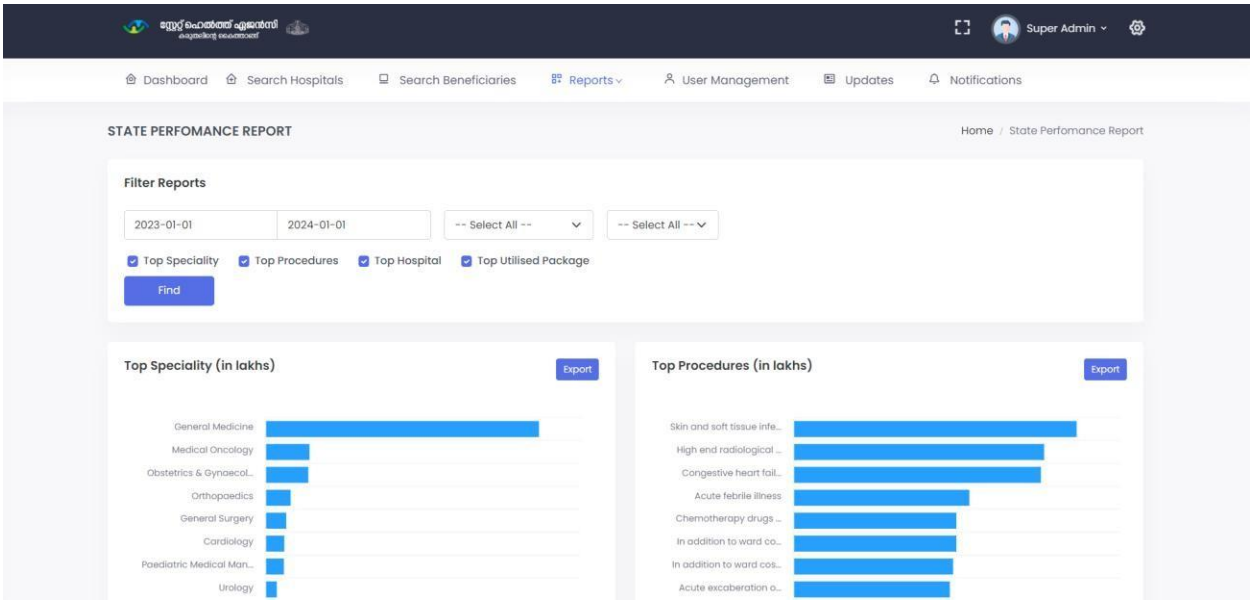

Figure 7: Web Portal for SHA

2.1. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Functioned as the project implementation and coordination agency responsible for conceptualization, funding, technical guidance, stakeholder coordination, project monitoring, and overall implementation management.
2	State Health Agency (SHA)	Served as the primary user department by providing functional requirements, validating system features, supporting User Acceptance Testing (UAT), and utilizing the portal for beneficiary management and reporting.
3	Qkopy Online Services Pvt Ltd	Functioned as the technology partner responsible for design, development, testing, deployment, and technical maintenance of the mobile application and web portal.
4	eHealth Kerala	Served as the data custodian by facilitating access to beneficiary and transactional healthcare data required for eligibility verification and reporting functionalities.
5	National Health Authority (NHA)	Supported the initiative through the provision of updated beneficiary information from NHA infrastructure.
6	KASP-PMJAY Beneficiaries	Served as the primary end users of the mobile application.
7	Empanelled Hospitals	Utilized the web portal for beneficiary verification and reporting functions.

Table 4: Stakeholders- Mobile App for SHA

2.5 Outcomes / Observations

The implementation of the KASP-PMJAY mobile application named **KASP Heath** (available on play store for free download) and web portal has contributed to improving accessibility to health insurance information and related services for beneficiaries across Kerala.

Beneficiaries are now able to independently verify eligibility status, access insurance balance information, identify empaneled hospitals, and receive important notifications through a centralized digital platform, thereby reducing dependence on physical kiosks and telephonic support mechanisms. This has improved accessibility, enhanced transparency, and increased awareness regarding scheme benefits among users.

The initiative has also contributed to strengthening the operational efficiency of the State Health Agency by reducing manual effort involved in report generation and administrative processes. Automated reporting mechanisms and dashboard-based monitoring functionalities have facilitated quicker access to analytical information required for decision-making and performance monitoring.

Additionally, the system has improved coordination among SHA officials, District Programme Coordinators (DPCs), and empaneled hospitals through centralized access to beneficiary and claims-related information, thereby supporting more efficient scheme monitoring and administration across districts.

Figure 8: Official Launch by Hon'ble Health Minister of Kerala

CHAPTER 3. COMPLETED PROJECTS

1. Immunochain

1.1. Problem Statement

Immunization programmes in Kerala largely depended on manual record keeping and fragmented data management systems, limiting the ability to effectively monitor vaccine coverage, beneficiary tracking, and vaccine traceability. Vaccination-related information was maintained across multiple physical records such as RCH books, immunization registers, Anganwadi records, and health centre ledgers, increasing duplication of effort and the possibility of errors.

There was also no effective mechanism to digitally link vaccine batches with beneficiaries, making it difficult to monitor vaccine administration, identify missed vaccinations, track beneficiaries across health centres, or conduct coverage analysis in real time. The absence of a centralized and technology-enabled immunization monitoring system limited data-driven decision-making and long-term vaccination tracking

1.2. Existing Challenges

The existing immunization process relied heavily on manual documentation and decentralized record keeping, creating operational inefficiencies and challenges in monitoring vaccine administration. Health officials were required to maintain vaccination information across multiple physical ledgers, increasing workload, duplication of effort, and the likelihood of errors.

Tracking vaccine beneficiaries and immunization schedules was also difficult, particularly when beneficiaries visited different healthcare institutions for subsequent vaccinations. The absence of a unified digital platform limited continuity of records, beneficiary traceability, and timely identification of missed vaccinations.

In addition, vaccine stock management and traceability remained largely manual, with no effective mechanism to link vaccine batch information to beneficiaries, making reverse tracking and recall management difficult. Preparation of periodic immunization reports required considerable manual effort by health officials, affecting operational efficiency.

1.3.K-DISC's Intervention

K-DISC supported the implementation of Immunochain, a blockchain-enabled vaccine coverage and traceability platform, to strengthen immunization monitoring, beneficiary tracking, and vaccine supply chain visibility under the Universal Immunization Programme (UIP). The

intervention focused on digitizing immunization workflows and enabling traceability across both the beneficiary side (mother and child) and the vaccine supply side.

The project supported the development of a digital immunization ecosystem comprising mobile applications, web-based platforms, blockchain infrastructure, and analytics systems for beneficiary registration, vaccine administration, stock management, QR-code-based identification, and immunization reporting. The intervention also included pilot testing to evaluate the feasibility of the system within public healthcare settings.

1.4. Technology Architecture and Key Functional Components

Immunochain was developed as a blockchain-enabled digital immunization platform designed to improve vaccine traceability, beneficiary tracking, immunization monitoring, and reporting. The architecture included blockchain infrastructure, mobile applications, web-based platforms, QR-code-enabled tracking mechanisms, and analytics dashboards to support immunization workflows

The key technology components include:

1. **Blockchain Infrastructure**

The system incorporated two blockchain networks—a Vaccine Chain for vaccine traceability and a Beneficiary Chain for mother and child immunization records—to support secure and tamper-resistant record management.

2. **Beneficiary Registration and Digital RCH System**

The platform enabled digital beneficiary registration and generation of QR-code-enabled RCH records, supporting digital access to mother and child immunization information.

3. **Vaccine Administration Mobile Application**

A mobile application supported vaccine administration, beneficiary verification, immunization tracking, and stock management for healthcare officials during immunization activities.

4. **QR Code-Based Vaccine and Beneficiary Tracking**

The system used QR-code-based identification mechanisms for both vaccine batches and beneficiaries to support traceability, authentication, and faster immunization workflows.

5. **Vaccine Stock Management Module**

The platform supported vaccine stock-in, stock-out, stock updates, and batch-level monitoring to improve vaccine supply chain visibility and accountability.

6. Analytics and Reporting Dashboard

A centralized dashboard enabled generation of immunization reports, coverage analysis, vaccine administration tracking, and stock monitoring to support healthcare administrators and field officials.

1.5. Stakeholders

#	Stakeholder	Role and Contribution
1	Kerala Development and Innovation Strategic Council (K-DISC)	Supported project implementation, stakeholder coordination, and pilot facilitation.
2	Kerala Blockchain Academy (KBA)	Functioned as the technology implementation partner responsible for development and deployment of the Immunochain platform.
3	Department of Health & Family Welfare, Government of Kerala	Supported implementation and integration with public immunization workflows under the Universal Immunization Programme (UIP).
4	Family Health Centre (FHC), Kadakampally	Functioned as the pilot institution for field testing and validation of the system.
5	District Vaccine Store, Thiruvananthapuram	Supported vaccine supply-side workflow validation and vaccine stock traceability during implementation.
6	Health Officials (JPHN/JHI/ASHA Workers)	Supported beneficiary registration, vaccine administration, immunization record validation, and field-level implementation.

Table 5: Stakeholders- Immunochain

1.6. Pilot Location

The pilot implementation of Immunochain was carried out at Family Health Centre (FHC), Kadakampally, along with the Thiruvananthapuram District Vaccine Store, to evaluate beneficiary registration, vaccine administration, vaccine traceability, and stock management workflows within the public immunization system. Field testing also included outreach immunization activities through selected Anganwadi centres.

1.7. Outcomes / Observations

The pilot implementation demonstrated improvements in digitization of immunization workflows, beneficiary tracking, vaccine traceability, and reporting efficiency. The system enabled QR-code-based beneficiary identification, reducing manual data entry and improving continuity of immunization records across vaccination visits. Health officials observed improved ease in tracking previously administered and pending vaccines during immunization sessions.

The pilot also demonstrated the feasibility of linking vaccine batches with beneficiaries, enabling traceability of vaccine administration and supporting batch-level monitoring. Immunization reporting and record management processes were simplified through digital dashboards, reducing manual effort involved in generating periodic reports. During the pilot period, 345 beneficiaries were registered and 624 immunizations were recorded for 326 children, demonstrating operational usability within a public healthcare setting.

2. Implementation of G-Gaiter- Gait Rehabilitator

2.1. Problem Statement

The increasing prevalence of neurological conditions such as spinal cord injuries, stroke, cerebral palsy, and Parkinson's disease has created a growing demand for rehabilitation services in Kerala. However, rehabilitation for patients with mobility impairments, particularly paraplegic patients, continues to rely heavily on manual gait training, which is labor-intensive, time-consuming, and places significant burden on therapists and rehabilitation centers.

The limited availability of specialized rehabilitation facilities and dependence on therapist-assisted training also affect rehabilitation efficiency and patient accessibility. This highlighted the need for an advanced technology-enabled rehabilitation solution capable of improving gait training efficiency, enhancing patient engagement, and optimizing clinical manpower utilization

2.2. Existing Challenges

Rehabilitation for patients with neurological conditions, particularly those with mobility impairments and paraplegia, remained highly dependent on manual therapist-assisted gait training, which is labor-intensive, repetitive, and time-consuming. Conventional rehabilitation often required prolonged therapy sessions and continuous physical assistance from therapists to support coordinated lower-limb movement and posture correction.

A major challenge within public healthcare settings was the limited availability of advanced rehabilitation technologies and specialized infrastructure required for intensive gait rehabilitation. This affected accessibility to structured rehabilitation services and constrained the number of patients who could be treated effectively within available institutional capacity.

In addition, therapist-assisted rehabilitation placed a significant physical and operational burden on healthcare professionals, particularly during repetitive gait training exercises. Patients requiring frequent rehabilitation sessions also faced challenges related to repeated hospital visits and prolonged recovery timelines, affecting continuity and efficiency of rehabilitation services.

2.3.K-DISC's Intervention

The potential of the project was identified through K-DISC's Innovation for Government (i4G) Initiative 2021, following which K-DISC conceptualized and implemented a pilot intervention to evaluate the feasibility of robotics-assisted gait rehabilitation within the public healthcare system. The project was funded and managed by K-DISC and implemented at General Hospital, Thiruvananthapuram.

The intervention focused on the deployment of the G-Gaiter Robotic Rehabilitator to support clinical rehabilitation of patients with gait impairments, particularly paraplegic patients, through repetitive and coordinated gait training. The project aimed to strengthen rehabilitation support within public healthcare institutions by enabling structured movement therapy and improving access to advanced rehabilitation technologies.

As part of the intervention, operator support was provided for the G-Gaiter, and basic training was conducted by the operator for doctors, therapists, and technicians to ensure the effective utilization of the robotic rehabilitation system. The initiative also sought to improve rehabilitation monitoring and patient follow-up by enabling healthcare professionals to better assess patient progress during therapy.

2.4. Technology Components

The G-Gaiter system integrates multiple technology components to support robotics-assisted gait rehabilitation for patients with mobility impairments. The system combines robotics, artificial intelligence (AI), sensor-based monitoring, and virtual reality (VR) technologies to support structured rehabilitation and improve patient engagement during therapy.

1. **Robotic Gait Assistance System:**

The system utilizes pneumatic actuators to support repetitive lower-limb movement and simulate natural gait patterns during rehabilitation. This assists patients in performing coordinated gait training exercises and supports motor re-learning.

2. **Dynamic Body Weight Support System:**

An integrated bodyweight support mechanism helps optimize posture and movement during therapy sessions, improving patient comfort and reducing the physical burden on therapists during rehabilitation.

3. **AI-Assisted Gait Training:**

The system incorporates AI-based algorithms to support precise and repetitive gait movements, enabling consistent rehabilitation sessions and assisting healthcare professionals in monitoring patient progress.

4. **Virtual Reality (VR)-Enabled Rehabilitation:**

Virtual Reality components are integrated to improve patient engagement and participation during therapy sessions, contributing to a more interactive rehabilitation experience.

5. **Sensor-Based Monitoring System:**

The device includes sensor-based monitoring features to support patient safety and enable personalized rehabilitation planning based on therapy performance and movement patterns.

Figure 9: G-Gaiter

2.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Functioned as the project implementation and coordination agency responsible for conceptualization, funding, technical guidance, stakeholder coordination, project monitoring, and overall implementation management.
2	General Hospital (GH), Thiruvananthapuram	The pilot healthcare institution where the device was deployed and tested in a live clinical environment.
3	Department of Health and Family Welfare, Govt of Kerala	Providing overall support, guidance, and healthcare knowledge resources for the implementation of the project.
4	Genrobotic Innovations Private Ltd.	The technology partner responsible for implementing and deployment at pilot location.

Table 6: Stakeholder- Implementation of G-Gaiter

2.6. Pilot Location

The pilot implementation of the G-Gaiter Robotic Rehabilitator was carried out at General Hospital, Thiruvananthapuram, based on the department recommendation, patient caseload requiring gait rehabilitation, and institutional readiness to support pilot implementation within a public healthcare setting.

2.7. Outcomes / Observations

Initial observations from the pilot implementation indicate that the G-Gaiter Robotic Rehabilitator has supported structured and repetitive gait training for patients undergoing rehabilitation. Clinical use of the system indicated improvements in the number of steps completed by patients within shorter therapy durations, suggesting potential benefits in rehabilitation efficiency and patient mobility outcomes.

The implementation also indicated potential benefits in terms of patient comfort and reduced physical burden on therapists during gait training sessions. In addition, the integration of Virtual Reality (VR)-based rehabilitation contributed to improved patient engagement and motivation during therapy sessions, supporting a more interactive rehabilitation experience.

As patient rehabilitation trials and clinical observations are ongoing, further assessment is expected to provide additional insights into the long-term effectiveness and scalability of robotics-assisted gait rehabilitation within public healthcare settings.

3. Artificial Intelligence based system for automatic screening of Diabetic Retinopathy

3.1. Problem Statement

Diabetic Retinopathy (DR) is a leading cause of preventable blindness among diabetic patients, requiring timely screening for early diagnosis and treatment. Under the *Nayanamritham* programme, the Kerala Health and Family Welfare Department deployed Non-Mydriatic Fundus Cameras across Family Health Centers (FHCs) to support systematic DR screening. However, retinal images captured at FHCs were required to be centrally analyzed at the Regional Institute of Ophthalmology (RIO), resulting in delays due to increasing workload and limited specialist availability.

Further, the retinal images captured were ungradeable, i.e., retinal images of insufficient quality for clinical assessment, resulting in repeated image acquisition, delayed diagnosis, and reduced screening efficiency. Since image quality assessment occurred only after centralized review, patients often had to revisit health facilities, affecting the timeliness and effectiveness of diabetic retinopathy screening.

3.2. Existing Challenges

The implementation of diabetic retinopathy (DR) screening under the *Nayanamritham* programme faced multiple operational challenges related to image quality, turnaround time, and scalability of centralized screening mechanisms.

A major challenge observed during screening was the high proportion of ungradable retinal images. It was observed that only approximately 82% of retinal images captured using fundus cameras were analyzable, while the remaining 18% were unsuitable for clinical assessment. Poor image quality often resulted in repeated image acquisition, delays in screening, and reduced operational efficiency. Since image quality assessment occurred only after centralized review, patients frequently left the health facility before retaking decisions could be communicated, necessitating additional visits.

Another significant challenge was the delay in retinal image analysis due to dependence on centralized review at the Regional Institute of Ophthalmology (RIO). Even with a limited number of connected Family Health Centers (FHCs), retinal image quality assessment and analysis typically required up to 48 hours, contributing to delays in diagnosis and clinical decision-making. The increasing diabetic population and limited availability of ophthalmology specialists further added to the burden on the existing screening model.

Further, the planned expansion of diabetic retinopathy screening across more than 172 Family Health Centers posed scalability concerns for the centralized screening approach. The anticipated increase in retinal image volume was expected to place substantial additional workload on specialist review systems, thereby affecting the efficiency and sustainability of large-scale population screening

3.3.K-DISC's Intervention

To address the challenges associated with diabetic retinopathy (DR) screening under the Nayanamritham programme, K-DISC initiated a pilot project in collaboration with the Centre for Development of Advanced Computing (C-DAC) to strengthen retinal image assessment and diabetic retinopathy screening at the Family Health Center (FHC) level.

The intervention was implemented in two phases. The first phase focused on the development of an ofline AI-based system to assess the gradability of retinal images. Building on the learnings from Phase I, the second phase focused on the development of a real-time system for retinal image quality assessment and diabetic retinopathy detection at the FHC level.

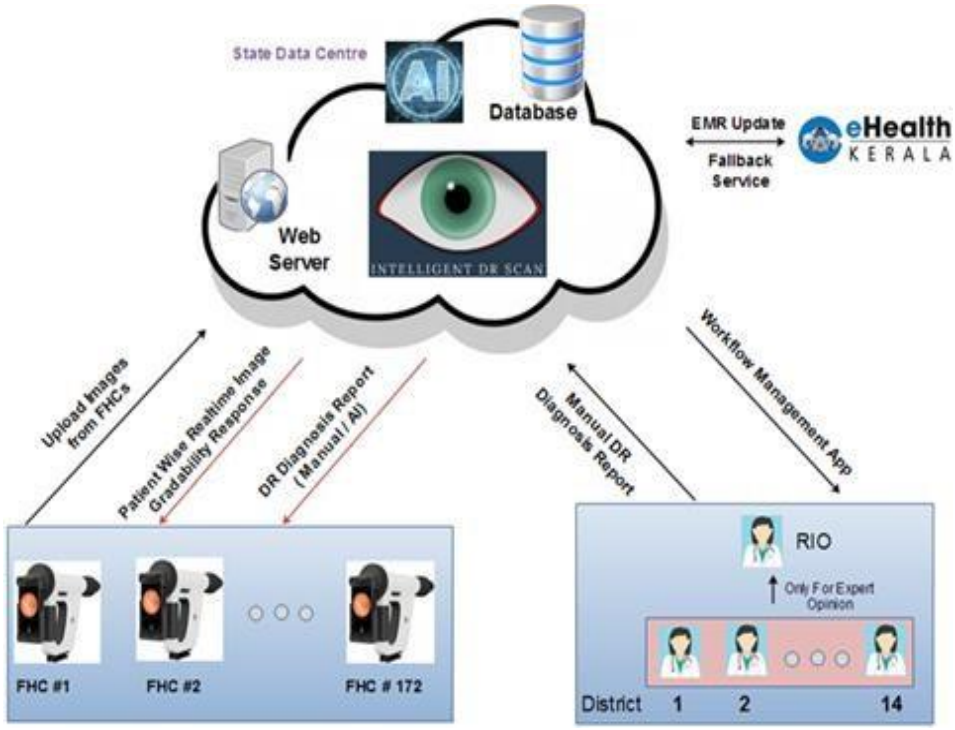

Figure 10: System Workflow- AI Based DR Detection System

The intervention aimed to improve the efficiency of diabetic retinopathy screening by strengthening retinal image assessment, reducing delays in screening workflows, and supporting large-scale population-level screening within the public healthcare system.

3.4. Technology Architecture and Key Functional Components

The solution was developed as an AI/ML-enabled real-time screening system for retinal image quality assessment and diabetic retinopathy (DR) screening at the Family Health Center (FHC) level. The system integrates automated image analysis, retinal image quality assessment, workflow management, and clinician support functionalities to strengthen large-scale diabetic retinopathy screening. The key functional components are as follows:

1. **AI/ML-Based Image Analysis Engine:**

The system utilizes deep learning models trained on retinal fundus images to support automated image gradability check and diabetic retinopathy detection. The engine enables identification of retinal abnormalities and generates AI-assisted screening outputs to support clinician review and validation.

2. **Real-Time Image Quality Assessment Module:**

A dedicated module evaluates the quality of retinal images in real time to determine whether captured images are suitable for clinical assessment. This enables healthcare workers to identify poor-quality images and initiate immediate retakes during patient visits, thereby reducing delays and repeated visits.

3. **Fundus Camera Integration Layer:**

The system is integrated with Non-Mydriatic Fundus Cameras (Remidio) to enable seamless image capture, transmission, and incorporation into the diabetic retinopathy screening workflow across Family Health Centers.

4. **DRISTI Web Portal and Monitoring Dashboard:**

A centralized web-based platform was developed to support clinicians and specialists in reviewing retinal images, validating screening outputs, and managing workflows. The portal includes case-wise review features, image visualization tools, structured reporting, analytics dashboards, and workflow management functionalities to support screening and clinical decision-making.

5. **Model Training and Continuous Improvement Framework:**

The solution incorporates a structured model training framework that enables periodic updates using clinically validated data to improve system performance, accuracy, and adaptability over time.

Collectively, these components form a scalable and technology-enabled screening ecosystem designed to support efficient diabetic retinopathy screening and strengthen population-level screening efforts within the public healthcare system

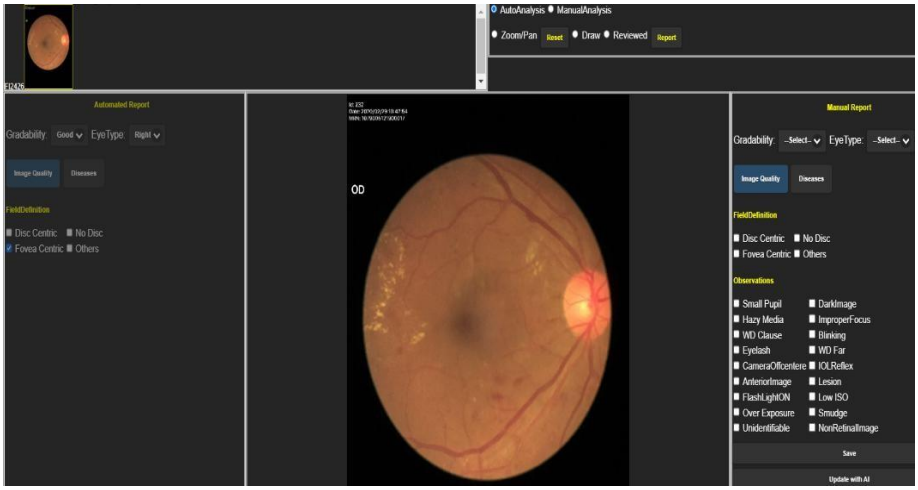

Figure 11: AI Based DR Detection System

3.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Functioned as the project implementation and coordination agency responsible for project conceptualization, funding, stakeholder coordination, technical guidance, and overall project management. K-DISC also monitored project progress and facilitated implementation activities.
2	Directorate of Health Services (DHS)	As the implementing agency of the *Nayanamritham* programme in Kerala, DHS functioned as the primary user department. DHS provided functional requirements, validated system functionalities, supported User Acceptance Testing (UAT), and facilitated implementation within Family Health Centers (FHCs).
3	Centre for Development of Advanced Computing (C-DAC)	Functioned as the technology partner responsible for the design, development, testing, deployment, and technical maintenance of the AI-based screening system and the DRISTI web platform.
4	eHealth Kerala	Supported the initiative by providing retinal image datasets required for AI model development, facilitating healthcare data management, and enabling PACS integration with the DRISTI platform to ensure interoperability.

Table 7: Stakeholders- AI Based DR Detection System

3.6. Pilot Location

The project was planned for implementation across the 172 Family Health Centers (FHCs) in Kerala where retinal screening devices had been deployed under the *Nayanamritham* programme. For pilot implementation, selected FHCs in Thiruvananthapuram district were identified based on operational readiness and availability of required infrastructure. However, certain practical challenges, including equipment-related issues and infrastructure limitations, affected field validation at the selected centers.

Consequently, field validation was substituted with a simulated image-upload process from FHC-Kadakampally to enable core system testing and assessment.

3.7. Outcomes / Observations

The AI-based Diabetic Retinopathy (DR) screening system was validated to assess its performance under practical screening conditions. The system demonstrated strong performance in both retinal image quality assessment and diabetic retinopathy detection. For retinal image quality assessment, the system achieved 99.17% sensitivity and 91.94% specificity, while for diabetic retinopathy detection, it achieved 95.15% sensitivity and 91.67% specificity. These results

indicate a high level of agreement with clinical assessment and demonstrate the system's reliability for screening purposes.

The validation also demonstrated the system's ability to support end-to-end diabetic retinopathy screening, including automated retinal image quality assessment and detection of key retinal abnormalities. By providing near real-time screening support, the system has the potential to improve screening efficiency, support early identification of diabetic retinopathy, and reduce the burden on centralized specialist review systems.

4. Antibiogram Application

4.1. Problem Statement

Government hospitals face challenges in implementing effective antibiotic stewardship practices due to increasing patient load and reliance on hardcopy treatment manuals. Limited access to updated antimicrobial guidelines and pathogen-specific treatment protocols can delay clinical decision-making and contribute to inappropriate antibiotic usage. The growing concern of antimicrobial resistance (AMR) highlights the need for accessible, standardized, and evidence-based antibiotic policies within healthcare institutions.

4.2. Existing Challenges

The Government healthcare institutions faced multiple challenges in ensuring effective implementation of antibiotic stewardship practices and adherence to hospital antibiotic policies. A major challenge was the limited accessibility of updated antimicrobial treatment guidelines, which were primarily available through printed manuals or departmental communications. In busy clinical environments, this often made it difficult for doctors to quickly access pathogen-specific treatment recommendations and antibiotic policies during patient management.

The dynamic nature of antimicrobial resistance (AMR) further increased complexity in clinical decision-making. Antibiotic policies and treatment recommendations required periodic revision based on evolving resistance patterns, microbiology reports, and institutional antibiogram data. Ensuring timely dissemination and consistent adoption of updated protocols across departments remained an operational challenge.

Another key challenge was the variation in antibiotic prescribing practices and limited availability of easily accessible decision-support tools at the point of care. In high-volume healthcare settings, dependence on hardcopy manuals and informal consultation mechanisms could contribute to delays in accessing relevant treatment guidance and inconsistencies in antibiotic prescription practices.

In addition, promoting consistent adherence to standardized antibiotic stewardship protocols among healthcare professionals required continuous awareness, training, and interdepartmental coordination. Limited digital integration and absence of centralized knowledge-sharing mechanisms further constrained efficient dissemination of antibiotic-related information and learning resources within the healthcare ecosystem

4.3.K-DISC's Intervention

K-DISC conceptualized and implemented an Antibiogram Application to strengthen antibiotic stewardship practices and improve accessibility to antimicrobial treatment guidance within government healthcare institutions. The intervention involved the development of a mobile and web-based conversational platform designed to support clinicians with timely access to antibiotic-related information and decision-support resources.

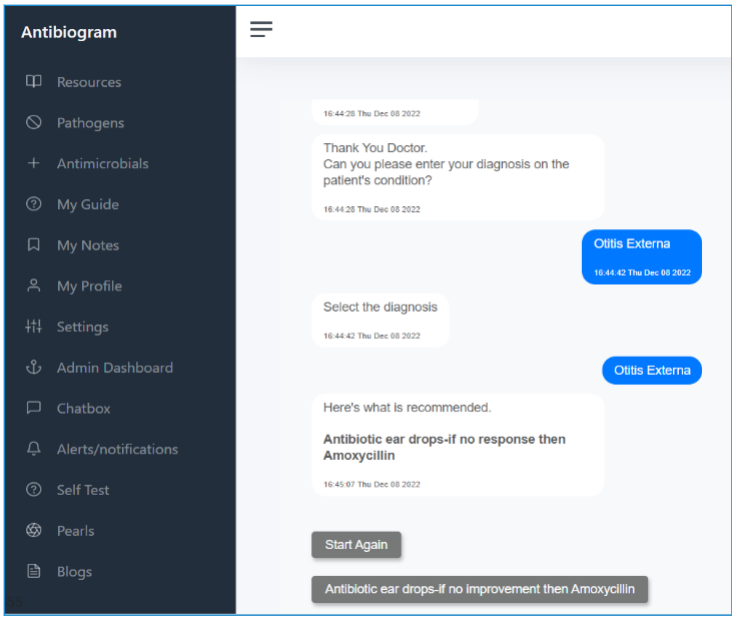

Figure 12:Antibiogram Application

The application was designed to provide ready access to antimicrobial resistance (AMR) resources and antibiotic policies issued by the Government of Kerala, along with pathogen-specific information, antibiotic recommendations, and treatment protocols relevant to different clinical specializations. The platform was also developed to support knowledge sharing and collaboration among healthcare professionals through features such as alerts, notifications, case discussions, and information-sharing tools.

In addition, the intervention incorporated interactive learning components, including self-assessment modules and simulation-based learning approaches, to strengthen awareness and

encourage adherence to evidence-based antibiotic treatment practices among healthcare professionals.

4.4. Technology Architecture and Key Functional Components

The Antibiogram Application was developed as an AI-enabled conversational platform designed to improve access to antimicrobial treatment guidance and antibiotic stewardship resources within healthcare institutions. The solution combines a conversational interface and graphical user interface (GUI) to support personalized and user-friendly access to relevant clinical information.

1. **AI-Enabled Conversational Interface (Chatbot):**

The platform incorporates a conversational chatbot to enable healthcare professionals to access antibiotic policies, pathogen-specific treatment guidance, antimicrobial resistance information, and recommended treatment protocols through natural language-based interactions. The chatbot was designed to provide quick and contextual access to information relevant to the clinician's area of specialization.

2. **Graphical User Interface (GUI):**

In addition to the conversational interface, the platform includes a web and mobile-based graphical interface enabling users to navigate antibiotic resources, treatment guidelines, notifications, and educational content through structured menus and dashboards.

3. **Knowledge Sharing and Collaboration Tools:**

The application supports clinical collaboration and knowledge dissemination through features such as alerts, notifications, case discussions, blogs, and sharing of treatment-related information among healthcare professionals.

4. **Interactive Learning and Training Modules:**

To strengthen awareness and adherence to antibiotic stewardship practices, the platform incorporates self-learning and simulation-based training features, including self-assessment tools and virtual clinical scenarios for practicing evidence-based treatment approaches.

4.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Functioned as the project implementation and coordination agency responsible for conceptualization, funding, technical guidance, stakeholder coordination,

		project monitoring, and overall implementation management.
2	Government Medical College Hospital (MCH), Thiruvananthapuram	Served as the primary user department by providing functional requirements, validating system features, supporting User Acceptance Testing (UAT), and utilizing the portal for beneficiary management and reporting.
3	Department of Health and Family Welfare, Govt of Kerala	Providing overall support, guidance, and healthcare knowledge resources for the implementation of the project.
4	Offcampus Test Technologies Pvt. Ltd.	Functioned as the technology partner responsible for design, development, testing, deployment, and technical maintenance of the mobile application and web portal.

Table 8: Stakeholders- Antibiogram

4.6. Pilot Location

The pilot implementation of the Antibiogram Application was carried out at the ENT Department, Government Medical College, Thiruvananthapuram. The department was selected to evaluate the feasibility and usability of the application within a clinical setting, particularly in supporting antibiotic stewardship practices, treatment decision-making, and access to antimicrobial guidelines during routine patient care.

4.7. Outcomes / Observations

The pilot implementation of the Antibiogram Application demonstrated the feasibility of using a digital conversational platform to support antibiotic stewardship practices within a clinical setting. The application improved accessibility to antibiotic policies, antimicrobial resistance (AMR) resources, treatment guidelines, and pathogen-specific information by consolidating information that was previously dispersed across multiple sources.

Initial observations indicated that the platform provided healthcare professionals with quicker and more convenient access to treatment-related information, supporting timely clinical decision-making and improving ease of reference during routine care. The collaboration and knowledge-sharing features also demonstrated potential to strengthen interaction among clinicians and facilitate exchange of clinical insights and treatment practices.

The pilot further highlighted the potential of digital learning and interactive engagement tools in supporting continuous medical education and improving awareness regarding rational antibiotic usage and antimicrobial resistance. Overall, the intervention demonstrated the potential of

technology-enabled solutions to strengthen antibiotic stewardship practices within government healthcare institutions.

5. Electronic Health Record Management using Blockchain

5.1. Problem Statement

The increasing digitization of healthcare services through eHealth Kerala, the State's integrated digital health platform, has improved electronic health record (EHR) management across public healthcare institutions. However, the storage and exchange of sensitive patient information, including Personally Identifiable Information (PII), within centralized systems raise concerns regarding data security, privacy, and unauthorized access. In the event of a security breach, sensitive patient information may be exposed, affecting patient confidentiality and trust in digital healthcare systems.

Further, the need for secure data sharing, traceability, and controlled access to health records highlighted the importance of strengthening the security framework for electronic health record management.

5.2. Existing Challenges

As part of the digital transformation of healthcare services, the eHealth Kerala system was widely used across government healthcare institutions for patient registration, treatment records, and healthcare service delivery. During this process, Aadhaar-linked information was also handled for patient identification and related service requirements.

With the increasing volume of digital health records, ensuring the secure handling of sensitive personal information emerged as a major challenge. Aadhaar-related information required enhanced protection due to its sensitive nature and regulatory requirements under UIDAI guidelines. Managing such information within conventional centralized systems created concerns related to secure storage, controlled access, protection against unauthorized use, and data privacy.

Another key challenge was the need to strengthen data security without disrupting the normal functioning of the existing eHealth platform used across healthcare institutions. Ensuring secure handling of sensitive patient information while maintaining interoperability and continuity of healthcare services remained an important operational requirement.

5.3.K-DISC's Intervention

K-DISC conceptualized and supported the development of a secure technology framework to strengthen the protection of Personally Identifiable Information (PII) linked to electronic health records within the eHealth Kerala platform.

The intervention focused on introducing a secure architecture for Aadhaar-related information management, wherein sensitive personal information was handled separately from core healthcare records to enhance data security and privacy. The solution incorporated encryption and secure access mechanisms to strengthen protection against unauthorized access and improve secure handling of sensitive patient information.

The project also supported functionalities related to the secure storage, retrieval, validation, and management of Aadhaar-linked information within the eHealth ecosystem, while ensuring continuity of existing healthcare operations.

5.4. Technology Architecture and Key Functional Components

The project incorporated multiple technology components to strengthen the secure management of Aadhaar-linked information within the eHealth Kerala ecosystem, while ensuring continuity of existing healthcare operations.

1. **Blockchain-Based Secure Data Management System (Hyperledger Fabric):**

The project utilized Hyperledger Fabric, a blockchain-based platform, to support secure handling of Aadhaar-related information. The blockchain layer enabled secure recording, validation, and traceability of transactions, thereby improving data integrity and strengthening protection against unauthorized modifications.

2. **Secure Aadhaar Data Storage Layer:**

A dedicated secure storage mechanism was designed to handle Aadhaar-linked information separately from core healthcare records, reducing risks associated with centralized storage of sensitive personal information and improving privacy protection.

3. **Encryption and Secure Key Management System:**

The solution incorporated encryption and secure key management mechanisms to strengthen the confidentiality and protection of sensitive Aadhaar-related information and support controlled access to data.

4. **eHealth Integration Interface:**

An integration layer was designed to enable secure interaction between the eHealth Kerala platform and the secure data management system, ensuring continuity of healthcare operations while supporting Aadhaar-related workflows without affecting the functioning of the existing eHealth system.

5. **Aadhaar Data Management Module:**

The system supported functionalities related to the secure registration, retrieval, validation, and management of Aadhaar-linked information, including duplicate checking and retrieval through healthcare identifiers to support healthcare service delivery.

6. **Security and Monitoring Mechanisms:**

The architecture also incorporated system monitoring and audit capabilities to support secure transaction tracking, access visibility, and operational oversight for managing sensitive healthcare-related information.

5.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Project ideation, implementation, coordination, technical oversight, and monitoring of the blockchain-based PII secure storage system.
2	Accubits Technologies Pvt Ltd	Technology partner responsible for development and implementation of the blockchain-based Aadhaar secure storage system.
3	eHealth Kerala	Provider of existing health system infrastructure, patient data, APIs, and integration environment for implementing the PII segregation solution.

Table 9: Stakeholders- Electronic Health Record Management

5.6. Outcomes / Observations

The project demonstrated the feasibility of implementing a secure framework for management of Aadhaar-linked information within the eHealth Kerala ecosystem. The implementation validated the use of secure storage, controlled access, and encryption mechanisms for handling sensitive personal information while maintaining access for authorized healthcare-related processes.

The project also demonstrated the integration of blockchain-based architecture and secure data management mechanisms within an existing government digital platform without affecting routine healthcare operations. Functionalities related to the storage, retrieval, validation, and

management of Aadhaar-related information were successfully tested during the implementation phase.

Subsequently, Aadhaar data management within the eHealth ecosystem transitioned to the State Aadhaar Data Vault as part of UIDAI compliance measures. The project outcomes and implementation experience provided technical inputs for understanding secure data management approaches within digital healthcare systems.

6. Implementation of Hekaflo-IoT Enabled High Flow Nasal Oxygen Therapy Device at MCH Thrissur and SAT Thiruvananthapuram

6.1. Problem Statement

Patients with moderate to severe respiratory distress often require oxygen support beyond the capacity of conventional oxygen delivery systems such as nasal cannulas and face masks, which provide limited oxygen flow and inconsistent oxygen concentration control. Inadequate humidification in conventional systems may also result in patient discomfort, airway irritation, and reduced effectiveness of therapy, increasing the likelihood of escalation to invasive ventilation and intensive care support.

Although High Flow Nasal Cannula (HFNC) therapy has emerged as an effective non-invasive respiratory support intervention, the high cost and dependence on imported systems have limited its wider adoption in government healthcare institutions. This highlighted the need for an affordable, clinically reliable, and scalable HFNC solution suitable for public healthcare settings in Kerala.

6.2. Existing Challenges

Government healthcare institutions faced multiple challenges in providing effective non-invasive respiratory support, particularly for patients requiring high-flow oxygen therapy. A major limitation was the dependence on imported High Flow Nasal Cannula (HFNC) systems, which involved high procurement and maintenance costs, limited-service support, and constraints in large-scale deployment across government hospitals. Supply chain disruptions during the COVID-19 pandemic further highlighted vulnerabilities associated with reliance on imported respiratory devices.

Conventional oxygen therapy systems were also limited in their ability to provide heated and humidified high-flow oxygen with precise oxygen concentration control, affecting patient comfort and therapy effectiveness, particularly in severe respiratory conditions. In addition, the limited

availability of respiratory support systems tailored for pediatric and neonatal care, along with the absence of digital integration and centralized monitoring capabilities, affected clinical visibility and efficient patient management in critical care settings.

6.3.K-DISC's Intervention

K-DISC conceptualized and implemented the project under the Innovation for Government (i4G) initiative to evaluate the feasibility of an IoT-enabled High Flow Nasal Oxygen Therapy (HFNC) system within government healthcare institutions. The intervention focused on introducing an indigenous, digitally integrated HFNC solution capable of delivering heated and humidified high-flow oxygen therapy while enabling real-time patient and device monitoring.

The project supported deployment of the HekaFlo HFNC system in selected government hospital ICUs to assess its clinical usability across adult, pediatric, and neonatal care settings. The intervention also included integration of remote monitoring capabilities, oxygen optimization features, and patient monitoring functions to strengthen respiratory care delivery in critical care environments.

6.4. Technology Architecture and Key Functional Components

The system integrates multiple technology components designed to support efficient respiratory care, patient monitoring, and digital healthcare integration. The key functional components are outlined below:

1. **High Flow Nasal Cannula (HFNC) System:**

The device delivers heated and humidified high-flow oxygen therapy with adjustable oxygen concentration and flow settings to support patients with varying respiratory requirements. The system supports therapy for adult, pediatric, and neonatal patients through customized flow settings.

2. **Integrated Humidification System:**

An integrated humidification mechanism helps maintain temperature and moisture levels during oxygen delivery, improving patient comfort and reducing airway irritation associated with prolonged oxygen therapy.

3. **Multi-Patient Therapy Modes:**

The system supports dedicated therapy modes for adult, pediatric, and neonatal care, enabling appropriate respiratory support based on patient age and clinical requirements.

4. Pulse Oximeter Integration:

A built-in pulse oximeter enables continuous monitoring of oxygen saturation (SpO_2) and pulse rate to support clinical assessment and treatment monitoring.

5. IoT-Enabled Remote Monitoring:

The solution is capable of web and mobile-based monitoring for real-time observation of patient and device parameters. The system is designed for monitoring purposes only, ensuring patient safety by preventing remote modification of therapy settings.

6. Touchscreen Interface and Safety Features:

The device incorporates a touchscreen-based user interface for therapy configuration, along with integrated alarms and safety mechanisms to support clinical operation.

7. Oxygen Optimization Features:

The system includes mechanisms to support efficient oxygen utilization, particularly during periods of high demand in critical care settings.

Figure 13: HekaFlo- HFNC Machine

6.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Project ideation, implementation, coordination, technical oversight, and monitoring of the blockchain-based PII secure storage system.
2	Health & Family Welfare Department, Government of Kerala	Provided administrative and institutional support for implementation of the project within government healthcare institutions and facilitated pilot deployment in hospital Intensive Care Units (ICUs).
3	Heka Medicals India Pvt. Ltd.	Functioned as the technology partner responsible for the design, development, supply, installation, commissioning, training, and operational support of the HekaFlo HFNC system.
4	SAT Hospital, Thiruvananthapuram	The Pediatric Intensive Care Unit (PICU) at SAT Hospital served as one of the pilot implementation sites for evaluating the pediatric respiratory support functionalities of the system.
5	Government Medical College, Thrissur	Served as a pilot implementation site for evaluating the HFNC system in ICU settings and supported clinical assessment, user feedback, and operational evaluation activities.

Table 10: Stakeholders- Implementation of HekaFlo-HFNC Machine

6.6. Pilot Location

The pilot implementation of the HekaFlo HFNC system was carried out at the following government healthcare institutions:

1. Pediatric ICU, SAT Hospital, Thiruvananthapuram
2. Anaesthesia ICU, Government Medical College Hospital, Thrissur

The pilot sites were selected to evaluate the system across pediatric, and adult critical care settings and to assess its operational suitability within government hospital ICU environments.

6.7. Outcomes / Observations

The pilot implementation demonstrated the operational feasibility of the HekaFlo HFNC system within government hospital ICU settings and its suitability for providing non-invasive respiratory support across different patient categories. The project also demonstrated the potential for deploying indigenous medical technology solutions within public healthcare institutions, reducing dependence on imported respiratory support systems.

The implementation highlighted several potential benefits, including improved accessibility to affordable respiratory care technology, enhanced patient monitoring, efficient oxygen utilization,

digital integration for remote monitoring, and scalability for wider adoption across government healthcare institutions in Kerala.

7. Automated Cervical Cancer Screening using Artificial Intelligence

7.1. Problem Statement

Cervical cancer remains a major public health concern among women in India, with early detection playing a critical role in reducing morbidity and mortality. In Kerala, cervical cancer screening is primarily carried out through Pap smear analysis in hospitals and outreach health camps. However, the screening process relies heavily on manual slide preparation and microscopic examination, often resulting in delays in diagnosis and reporting. Further, poor-quality smear samples can affect diagnostic accuracy, leading to repeat testing and reduced screening efficiency.

7.2. Existing Challenges

Prior to the implementation of the project, cervical cancer screening in government healthcare institutions was predominantly dependent on conventional manual Pap smear analysis. Under the existing workflow, smear samples collected from Gynecology Outpatient Departments (OPs) and screening camps were manually prepared on glass slides, labeled, and physically transported to pathology laboratories for microscopic examination by cytotechnicians and pathologists. This process was time-consuming and highly dependent on the availability, expertise, and workload of trained healthcare professionals.

A major operational challenge was the limited availability of trained cytotechnicians and pathologists, particularly in high-volume government healthcare settings. As patient load increased, manual microscopic examination required significant review time, affecting screening turnaround time and limiting the number of samples that could be processed on a daily basis. This created operational bottlenecks in achieving timely diagnosis and large-scale population screening.

The existing screening methodology also faced several technical limitations associated with conventional Pap smear analysis. Variations in smear preparation, overlapping cells, inadequate sample collection, and the presence of blood, mucus, or inflammatory material often affected slide quality and microscopic visibility. Poor-quality smear samples reduced diagnostic

consistency and, in certain cases, necessitated repeat testing, leading to delays in diagnosis and patient inconvenience.

In addition, the absence of digital pathology infrastructure and automated screening support systems limited opportunities for standardization, workflow optimization, and timely clinical review. Screening processes remained heavily dependent on manual interpretation, making scalability difficult, particularly in rural outreach settings and large public healthcare institutions handling substantial screening volumes.

These operational and technical challenges affected the timeliness, efficiency, and scalability of cervical cancer screening, highlighting the need to explore innovative approaches for strengthening early detection and screening workflows within the public healthcare system.

7.3.K-DISC's Intervention

K-DISC conceptualized and implemented the project "Automated Cervical Cancer Screening Using Artificial Intelligence" as a pilot initiative to explore the integration of Artificial Intelligence (AI), digital pathology, and Liquid-Based Cytology (LBC) technologies within the government healthcare system for cervical cancer screening. The intervention was undertaken in collaboration with the Health & Family Welfare Department, SAT Hospital Government Medical College Thiruvananthapuram, Malabar Cancer Centre (MCC), and the technology partner Nex Fitzap Pvt. Ltd. (Logy.AI).

The intervention focused on establishing a digital cervical cancer screening ecosystem by introducing Liquid-Based Cytology (LBC) technology, digital pathology workflows, and AI-assisted screening support within a government healthcare setting. As part of the project, LBC infrastructure, digital pathology systems, and a web-based pathology platform were deployed to support digital sample management, reporting, and workflow tracking.

Further, an AI-enabled screening system was developed to support automated analysis of cervical cytology samples and assist pathologists in screening workflows. The solution was integrated with secure digital infrastructure to enable streamlined sample review, annotation, and reporting within the public healthcare environment.

7.4. Technology Architecture and Key Functional Components

The project introduced multiple technology components aimed at modernizing cervical cancer screening workflows and evaluating the feasibility of AI-assisted digital cytology within government healthcare institutions.

1. **Liquid-Based Cytology (LBC) Technology:**

The project introduced Liquid-Based Cytology (LBC) technology to improve sample quality and standardization compared to conventional Pap smear methods. LBC infrastructure, including an automated cytology processor and consumable systems, was deployed to support improved sample preparation, better cellular preservation, and enhanced suitability for digital image analysis. The system also established a foundation for future molecular diagnostic workflows.

2. **Digital Pathology and Slide Digitization System:**

A digital microscopy system was deployed to enable the conversion of physical cytology slides into high-resolution digital images for screening, review, and storage. The digital pathology workflow supported centralized access to digitized slides and reduced dependence on physical slide handling, while enabling future telepathology and AI-assisted review possibilities.

3. **AI/ML-Based Screening Model:**

An AI-assisted cervical cytology screening model was developed to support automated identification and classification of cervical cell types and assist pathologists in screening workflows. The system was designed to support cell detection, abnormality identification, and pathology review assistance through digital cytology analysis.

4. **Web-Based Pathology Platform:**

A web-based pathology platform was developed with role-based access for administrators, technicians, and pathologists. The platform enabled digital sample registration, image upload, pathology review, annotation, workflow tracking, and report management, supporting streamlined digital screening workflows.

5. **Annotation and Training Dataset Framework:**

A structured annotation framework was implemented with support from domain experts to create clinically relevant datasets for AI model training and validation. The initiative contributed to the development of annotated cervical cytology datasets for future research and model improvement.

6. **Secure Digital Infrastructure:**

The pathology platform, AI application, and associated datasets were deployed within the Kerala State Data Centre (SDC) with secured access mechanisms and de-identified patient information to support data privacy, confidentiality, and future scalability.

7.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Project ideation, implementation, coordination, technical oversight, and monitoring of the blockchain-based PII secure storage system.
2	Health & Family Welfare Department, Government of Kerala	Provided administrative, institutional, and policy-level support for implementation of the project within government healthcare institutions and facilitated coordination with relevant stakeholders.
3	SAT Hospital, Government Medical College, Thiruvananthapuram	Functioned as the primary pilot implementation site and supported patient screening, cervical sample collection, Liquid-Based Cytology (LBC) slide preparation, and operational execution of the project.
4	Department of Pathology & Department of Gynecology, SAT Hospital	Supported patient identification, cervical sample collection, cytology slide preparation, pathological review, and clinical validation activities throughout the project lifecycle.
5	Nex Fitzap Pvt. Ltd. (Logy.AI)	Functioned as the technology partner responsible for the development of the AI-assisted cervical cancer screening platform, including AI/ML model development, digital pathology workflows, and deployment support.
6	VDNA Laboratories (Eziprep)	Supplied the Liquid-Based Cytology (LBC) infrastructure, including the cytology autoprocessor, consumables, and associated technical support required for project implementation.
7	Medprime Technologies Pvt. Ltd.	Provided digital microscopy support for slide digitization and image acquisition required for AI model development, annotation, and digital pathology workflows.
8	Malabar Cancer Centre (MCC)	Provided expert annotation and domain support for AI model training, including expert review of cervical cytology images and generation of annotated datasets required for model development and validation.

Table 11: Stakeholders- AI Based Detection of Cervical Cancer

7.6. Pilot Location

The pilot implementation was carried out at SAT Hospital, Government Medical College, Thiruvananthapuram. The institution was selected due to its established Gynecology and Pathology departments, regular cervical screening activities, and availability of the clinical and laboratory infrastructure required for pilot implementation. The project was integrated into the existing cervical cytology screening workflow to assess the feasibility of AI-assisted cervical cancer screening within a government healthcare setting.

7.7. Outcomes / Observations

The project successfully demonstrated the feasibility of establishing digital cytology infrastructure and AI-assisted pathology workflows within a government healthcare setting. The initiative enabled implementation of Liquid-Based Cytology (LBC), digital slide digitization, pathology workflow digitization, and AI-supported screening processes, providing important insights into the practical requirements of AI-enabled cervical cancer screening.

The project highlighted several important observations for future healthcare AI initiatives. It was observed that AI-based cervical screening requires large, diverse, and high-quality annotated datasets to achieve clinically reliable performance. The project also highlighted the importance of sustained institutional support, dedicated manpower, and multi-institutional collaboration for successful AI implementation in healthcare.

8. Wireless Infusion Monitor with Dripo at Malabar Cancer Centre

8.1. Problem Statement

Current IV infusion management in hospitals relies heavily on manual monitoring, making it difficult to continuously track infusion status and identify critical conditions such as empty IV bags, blood backflow, air embolism, and dosing irregularities in a timely manner. Dependence on nurses, patients, or attendants for monitoring increases workload, delays in intervention, and the risk of human error. In addition, the absence of real-time alerts and digital infusion monitoring affects patient safety, treatment efficiency, and record management within healthcare settings.

8.2. Existing Challenges

The existing IV infusion management process in hospitals is predominantly dependent on manual observation by nurses, healthcare staff, and patient attendants, creating several operational, clinical, and patient safety challenges. In busy inpatient wards and critical care settings, healthcare personnel are often required to monitor multiple patients receiving intravenous (IV) fluids or medications simultaneously, making continuous supervision difficult and increasing the possibility of delayed intervention.

At present, there is no effective real-time monitoring mechanism to continuously track the status of IV infusions and immediately alert healthcare personnel during critical situations. Conditions such as empty IV bags, blood backflow into tubing, air embolism risk, occlusions, improper infusion flow, and patient discomfort may not be identified promptly, particularly in situations where healthcare staff are attending to multiple clinical responsibilities. Delayed detection of such events can adversely affect patient safety, treatment outcomes, and continuity of care.

Another major challenge is the high workload on nursing staff, who are required to manually check infusion levels, adjust flow rates, calculate dosing schedules, and ensure timely replacement of IV fluids and medications. This manual and repetitive monitoring process increases physical workload, operational stress, and the risk of oversight, especially in high patient-load environments.

The process also involves manual calculation and adjustment of infusion rates and medication dosing, which may increase the risk of human error, potentially affecting dosage accuracy and treatment quality. In addition, healthcare institutions often lack a centralized digital mechanism for recording infusion schedules, dosing history, treatment timelines, and alerts, limiting effective monitoring, auditability, and future clinical reference.

These limitations highlight the need for an automated and intelligent IV infusion monitoring and alert system capable of providing continuous monitoring, real-time notifications, improved dosing accuracy, and digital record management, thereby improving patient safety, reducing workload on healthcare staff, and enhancing overall healthcare efficiency.

8.3.K-DISC's Intervention

K-DISC conceptualized and implemented the project under the Innovation for Government (i4G) initiative to evaluate the feasibility of an IoT-enabled smart IV infusion monitoring system within Government healthcare institutions. The intervention focused on improving the safety, accuracy, and monitoring of intravenous (IV) medication delivery through real-time infusion monitoring and automated alert mechanisms.

The project supported the deployment of the Dripo Smart Infusion Monitoring System at Malabar Cancer Centre (MCC), Thalassery, including installation of monitoring units in selected care settings and a centralized monitoring platform for healthcare providers. The system was designed to support continuous monitoring of infusion status, detection of abnormal infusion conditions, and timely alerts for healthcare personnel to improve patient safety and operational efficiency.

The intervention also included validation and assessment activities to evaluate the performance, reliability, and feasibility of the system in comparison with conventional infusion monitoring practices within hospital settings.

8.4. Technology Architecture and Key Functional Components

The Dripo Smart Infusion Monitoring System was developed as an IoT-enabled healthcare monitoring solution for continuous and real-time supervision of Intravenous (IV) infusion therapy in hospital settings. The system was designed to strengthen patient safety by enabling automated

monitoring of infusion status, early detection of abnormalities, and timely alerts to healthcare personnel.

The technology architecture consists of portable infusion monitoring devices, wireless communication systems, centralized monitoring infrastructure, and digital dashboards for healthcare providers. The system supports real-time monitoring of infusion parameters and enables centralized supervision of multiple patients simultaneously.

The key technology components of the system include:

1. **Portable IV Infusion Monitoring Device**

A compact monitoring device designed to be attached to conventional IV infusion setups for continuous supervision of infusion activity and status.

2. **Infusion Monitoring and Sensing System**

The system continuously monitors infusion parameters such as flow rate, fluid depletion, and abnormal flow conditions, enabling early detection of interruptions or irregularities during infusion.

3. **IoT-Based Communication Framework**

The solution incorporates IoT-enabled wireless communication mechanisms for transmitting infusion-related information to centralized monitoring systems, enabling real-time remote supervision.

4. **Centralized Monitoring Platform**

A digital monitoring platform designed to support aggregation, visualization, and centralized supervision of infusion-related data across multiple patients and hospital wards.

5. **Real-Time Alert and Notification System**

The system generates alerts for conditions such as empty IV bags, flow irregularities, blockages, and other abnormal infusion events, enabling timely intervention by healthcare personnel.

6. **Centralized Nursing Dashboard**

A unified digital dashboard that enables healthcare staff to monitor multiple patients simultaneously, improving operational efficiency, visibility, and patient safety during IV therapy management.

Figure 14: Dripo Device

8.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Functioned as the project implementation and coordination agency, supporting conceptualization, funding, stakeholder coordination, pilot implementation, and monitoring of the project under the Innovation for Government (i4G) initiative.
2	Malabar Cancer Centre (MCC), Thalassery	Functioned as the pilot institution for implementation and evaluation of the smart infusion monitoring system within clinical settings, supporting validation of infusion workflows and operational feasibility.
3	Evelabs Technologies Private Limited	Functioned as the technology partner responsible for development, deployment, installation, and technical support of the Dripo Smart Infusion Monitoring System and associated monitoring platform.

Table 12: Stakeholders- Wireless Infusion Monitoring with Dripo

8.6. Pilot Location

The pilot implementation of the Dripo Smart Infusion Monitoring System was carried out at Malabar Cancer Centre (MCC), Thalassery, covering selected clinical departments including the Daily Chemo Ward, Critical Care Unit I, and Critical Care Unit II. The project involved deployment of smart infusion monitoring units along with a centralized monitoring platform accessible at nursing stations for real-time supervision of IV infusion activities.

The pilot included monitoring and evaluation of infusion workflows, assessment of infusion-related events through electronic monitoring, and comparative evaluation of smart infusion monitoring with conventional practices. Training and handholding support were also provided to

healthcare personnel to facilitate effective adoption and utilization of the system during implementation.

Figure 15:Wireless Infusion Monitoring with Dripo- Project launch by by Hon.Chief Minister at MCC

8.7. Outcomes / Observations

The pilot implementation of the Dripo Smart Infusion Monitoring System demonstrated improvements in IV infusion monitoring, patient safety, and nursing supervision within the clinical setting. The system enabled real-time monitoring and alert-based supervision of infusion activities, supporting timely intervention during abnormal infusion conditions and reducing dependency on continuous manual observation.

The implementation also highlighted limitations associated with conventional gravity-based infusion monitoring, particularly in maintaining infusion accuracy and continuous supervision in high patient-load environments. The smart monitoring approach supported improved visibility of infusion status, reduction in monitoring burden on nursing staff, and better operational oversight, especially in settings with limited nurse-to-patient ratios.

Overall, the pilot demonstrated the operational feasibility and potential effectiveness of smart infusion monitoring systems in strengthening infusion safety, monitoring efficiency, and treatment supervision within Government healthcare institutions.

CHAPTER 4. ON GOING PILOT PROJECTS

1. AI Based OP Token Slot Prediction System for Hospitals

1.1. Problem Statement

Patients visiting Outpatient (OP) departments in government hospitals often experience long and uncertain waiting times due to the absence of a mechanism to estimate consultation time based on token number and patient flow. As a result, patients face inconvenience, overcrowding in waiting areas, and difficulty in planning related hospital activities such as laboratory investigations, pharmacy visits, and report collection.

The lack of visibility regarding expected consultation time also affects patient experience and operational efficiency within high-volume hospital OP settings.

1.2. Existing Challenges

Government hospital Outpatient (OP) departments faced several operational challenges in managing patient flow and waiting times. Patients were typically required to wait without visibility regarding their expected consultation time, leading to overcrowding in waiting areas and inconvenience in planning related hospital activities such as laboratory visits, pharmacy visits, and report collection.

Another major challenge was the absence of data-driven mechanisms to predict consultation time or patient queue movement based on token number, doctor consultation patterns, and patient load. In high-volume departments, variations in consultation duration and patient inflow further affected predictability and operational efficiency, limiting the ability to provide patients with accurate waiting-time information.

In addition, the lack of real-time integration of patient flow information constrained opportunities for improving queue management and enhancing patient experience within hospital OP settings.

1.3.K-DISC's Intervention

K-DISC conceptualized and implemented an AI-based OP Token Slot Prediction System to address challenges associated with long and uncertain waiting times in hospital Outpatient (OP)

departments. The intervention focused on developing a data-driven prediction system capable of estimating approximate consultation time slots based on historical and real-time OP workflow data, including patient flow patterns and consultation trends.

The solution was designed to provide patients with estimated consultation timings through mobile applications, web interfaces, and kiosk-based systems, enabling better planning of hospital-related activities and improving patient convenience within high-volume OP settings.

1.4. Technology Architecture and Key Functional Components

The AI-Based OP Token Slot Prediction System integrates multiple technology components to support consultation time prediction, real-time patient flow monitoring, and patient communication within hospital Outpatient (OP) departments.

1. **AI/ML-Based Consultation Time Prediction Engine:**

The system utilizes Artificial Intelligence (AI) and Machine Learning (ML) models to estimate approximate consultation time slots based on historical consultation patterns, token flow, patient load, and real-time OP workflow data. The prediction engine is designed to improve waiting-time visibility for patients.

2. **Real-Time Event Streaming and Data Integration:**

A Kafka-based real-time event streaming mechanism and API integration with the eHealth platform enable continuous synchronization of patient registration, token movement, and consultation workflow data required for prediction and monitoring.

3. **Patient Information Interfaces:**

The solution includes mobile, web, and kiosk-based interfaces to provide patients with estimated consultation times and token-related information, enabling better planning of hospital-related activities.

4. **Barcode Scanning and Queue Tracking:**

The system incorporates barcode-based tracking mechanisms to support patient identification and improve accuracy in token and queue management processes.

5. **Multilingual Voice Support:**

To improve accessibility and usability, the system includes multilingual voice-enabled support for patient announcements and interaction within hospital settings.

6. **Secure Deployment Infrastructure:**

The application is designed for deployment through the State Data Centre (SDC) infrastructure to support secure system hosting and integration with existing government healthcare platforms.

1.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Functioned as the project implementation and coordination agency responsible for project conceptualization, funding, stakeholder coordination, monitoring, and overall project management.
2	eHealth Kerala	Supported the project by providing OP workflow data, Kafka-based event streaming, and API integration support required for development and integration of the AI-Based OP Token Slot Prediction System.
3	Bagmo Pvt. Ltd.	Functioned as the technology partner responsible for the design, development, and implementation of the AI-Based OP Token Slot Prediction System.
4	Government Medical College Hospital, Thiruvananthapuram	Functioned as a pilot implementation site for validating the system within high-volume outpatient department workflows.
5	Family Health Centre (FHC), Poozhanad	Functioned as a pilot implementation site to assess the feasibility of the system within a primary healthcare setting.

Table 13: Stakeholders- AI Based OP Token Slot Prediction System

1.6. Pilot Location

The pilot implementation of the AI-Based OP Token Slot Prediction System was carried out at the following healthcare institutions:

1. Gastroenterology Department OP, Government Medical College Hospital, Thiruvananthapuram
2. Family Health Centre (FHC), Poozhanad, Thiruvananthapuram

The pilot locations were selected to evaluate the feasibility of the system across different healthcare settings, including a high-volume tertiary care hospital outpatient department and a primary healthcare institution, to assess its applicability under varying patient flow conditions.

1.7. Expected Benefits

The AI-Based OP Token Slot Prediction System is expected to improve patient convenience and OP service delivery by providing estimated consultation time information based on token movement and consultation patterns. The solution is intended to reduce uncertainty in waiting

times, support better patient flow management, and enhance the overall outpatient experience through timely access to consultation time information.

Key expected benefits include:

- Improved patient convenience through the availability of estimated consultation time slots.
- Reduced uncertainty and waiting time in hospital OP departments.
- Better planning of hospital-related activities such as laboratory visits, pharmacy visits, and report collection.
- Reduced overcrowding in OP waiting areas through improved visibility of patient queue movement.
- Enhanced patient experience through timely access to consultation time information.
- Improved OP workflow and patient flow management using data-driven consultation time prediction.
- Increased accessibility through web, kiosk, and voice-enabled interfaces.
- Integration with the eHealth platform for wider dissemination of consultation time information through digital channels.
- A scalable solution that can be extended to other departments and healthcare institutions across the State.

2. AI Chatbot for eHealth

2.1. Problem Statement

Citizens using the eHealth Kerala ecosystem faced difficulties in accessing timely and centralized healthcare information, as services such as appointments, registrations (UHID/ABHA ID), screening details, and health scheme information were distributed across multiple platforms. The absence of a unified and easily accessible information system increased dependence on hospital helpdesks and DISHA call centres, resulting in delays and operational inefficiencies.

Further, limited multilingual and round-the-clock support affected accessibility, particularly for citizens requiring quick access to healthcare-related information and guidance. These challenges affected the overall citizen experience within the digital healthcare ecosystem.

2.2. Existing Challenges

The digital healthcare ecosystem under eHealth Kerala comprised multiple services related to appointments, registrations, screening programmes, health schemes, and hospital information, delivered through different platforms and institutional channels. As a result, citizens often faced

difficulties in identifying the appropriate source of information and navigating healthcare services in a timely manner. Accessing healthcare-related information frequently required interaction with multiple systems or physical visits to healthcare institutions.

A major challenge was the dependence on hospital helpdesks, frontline staff, and DISHA call centres for obtaining routine healthcare information such as appointment details, registration support, screening schedules, and service availability. This increased operational workload on healthcare staff and support systems, particularly in high-demand public healthcare settings, while also contributing to delays in citizen response and grievance handling.

Another key challenge was the absence of a unified and interactive citizen support mechanism capable of providing healthcare-related information through a single point of access. Existing systems had limited multilingual capabilities and lacked round-the-clock support, conversational interaction, and intelligent query handling, affecting accessibility and ease of use for citizens with varying levels of digital literacy.

Further, the fragmented availability of healthcare information limited opportunities for seamless integration of citizen-facing services such as appointment booking, UHID and ABHA registration, screening status retrieval, health awareness information, and hospital-related guidance, affecting overall user experience within the digital healthcare ecosystem.

2.3.K-DISC's Intervention

K-DISC conceptualized and implemented the "AI Chatbot for eHealth" project to improve citizen access to healthcare information and digital health services within the eHealth Kerala ecosystem. The intervention focused on developing an AI-powered conversational platform integrated with eHealth to provide a centralized and user-friendly interface for accessing healthcare-related services and information.

The chatbot was designed as a multilingual and voice-enabled platform to support citizens in accessing services such as online appointment booking, UHID and ABHA registration, screening status retrieval, hospital information, and public health awareness content through a single interface. The intervention aimed to improve accessibility, reduce dependency on hospital helpdesks and call centres, and enhance citizen convenience in navigating healthcare services.

2.4. Technology Architecture and Key Functional Components

The AI Chatbot for eHealth integrates multiple technology components to support citizen interaction, multilingual communication, and access to healthcare-related services within the eHealth Kerala ecosystem.

1. **Artificial Intelligence (AI) and Natural Language Processing (NLP) Engine:**

The chatbot incorporates Artificial Intelligence (AI) and Natural Language Processing (NLP) technologies to understand citizen queries and provide relevant responses in a conversational format. The system is designed to support healthcare-related information retrieval and service navigation through natural language interaction.

2. **Large Language Model (LLM)-Based Conversational Support:**

The solution utilizes Large Language Models (LLMs) to improve contextual understanding and enable intelligent handling of citizen queries related to appointments, registrations, screening services, hospital information, and health schemes.

3. **Voice-to-Text and Text-to-Voice System:**

The chatbot includes voice interaction capabilities through speech-to-text and text-to-speech technologies, enabling users to interact with the platform through voice commands and receive spoken responses.

4. **Multilingual Support Framework:**

The system supports multilingual interaction to improve accessibility for citizens and enable healthcare information access in different languages.

5. **eHealth Integration Layer:**

The chatbot is integrated with the eHealth Kerala platform through secure APIs to support citizen-facing services such as appointment booking, UHID and ABHA registration, screening status retrieval, and healthcare information access.

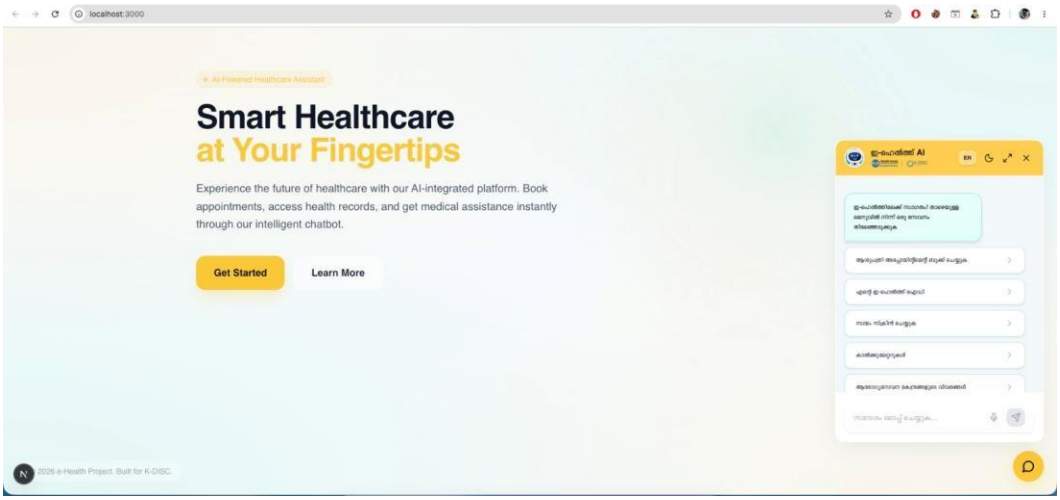

Figure 16: AI Chatbot

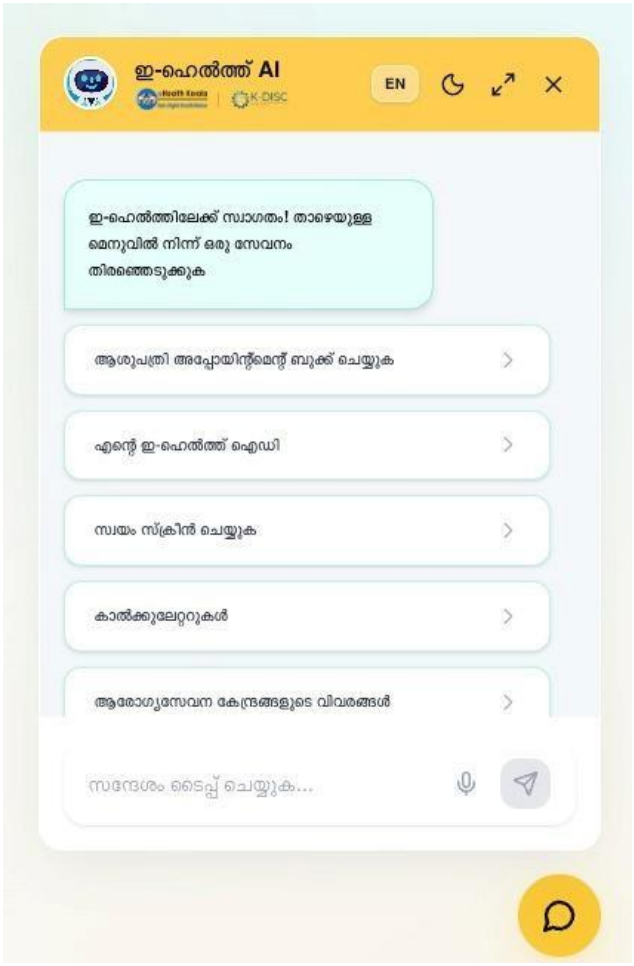

Figure 17: AI Chat bot

2.5. Stakeholders

#	Stakeholder	Role and Contribution
1	K-DISC	Functioned as the project implementation and coordination agency responsible for project conceptualization, funding, stakeholder coordination, monitoring, and overall project management.
2	Department of Health & Family Welfare, Government of Kerala	Provided overall administrative and institutional support for implementation of the project and facilitated access to healthcare knowledge resources and stakeholder coordination.
3	eHealth Kerala	Supported the project through integration support, API access, and connectivity with eHealth services required for chatbot functionality and service delivery.
4	BzAnalytics Private Limited	Functioned as the technology partner responsible for the design, development, deployment, testing, implementation, and technical support of the AI Chatbot platform.

Table 14: Stakeholders- AI Chatbot for eHealth

2.6. Expected Benefits

- **Improved Access to Healthcare Services:** Enabled seamless access to eHealth services, UHID/ABHA registration, and online appointment booking through a unified platform.
- **Enhanced Healthcare Awareness and Accessibility:** Provided easy access to government healthcare facility information and enabled digital cancer and NCD screening through awareness resources, self-assessment tools, and real-time status tracking, supporting informed healthcare decisions and early disease detection.
- **Improved Maternal and Child Health Outcomes:** Offered integrated access to pregnancy support, due date tracking, immunization and nutrition planning, child welfare programs, and health assessment tools, enabling informed decision-making and better maternal and child healthcare.
- **Increased Accessibility and User Inclusion:** Delivered multilingual, voice-enabled support in English and Malayalam, improving usability for diverse user groups.
- **Secure, Scalable, and Future-Ready Solution:** Ensured secure operations through rigorous testing while supporting future healthcare integrations and expansion.

3. Kerala Bone Marrow Registry

3.1. Problem Statement

Patients requiring Bone Marrow Transplantation (BMT) face significant challenges in identifying suitable donors due to the absence of a functional indigenous bone marrow donor registrys within the State. Donor matching currently depends on manual processes and external registries, resulting in delays, high costs, and limited accessibility.

At present, Malabar Cancer Centre (MCC), Thalassery, receives around 50 BMT patients annually, yet less than 30% are able to identify suitable donors through existing mechanisms. In addition, processes related to donor registration, HLA testing, donor matching, and transplant follow-up remain largely non-digitized, while private donor matching services may cost approximately ₹6–8 lakhs, making transplantation financially challenging for many patients.

3.2. Existing Challenges

Kerala did not have a functional state-level bone marrow donor registry integrated with the public healthcare system, limiting the availability of a searchable and accessible donor database. The absence of a centralized registry significantly reduced the probability of identifying compatible stem cell donors in a timely manner, particularly for patients requiring urgent Bone Marrow Transplantation (BMT).

The processes related to donor registration, patient registration, HLA testing, donor matching, and transplant follow-up were largely manual and institution specific. There was no standardized digital workflow connecting donor registration centres, transplant centres, HLA laboratories, and clinical follow-up systems. This resulted in delays in donor identification, duplication of records, manual errors, fragmented information management, and lack of real-time visibility into donor-patient matching activities.

Another major challenge was the lack of interoperability between transplant-related workflows and existing Government digital health systems, limiting continuity of care and long-term patient tracking. The absence of integrated digital records affected coordination between institutions involved in transplantation and follow-up care.

In addition, the donor matching process remained operationally expensive and dependent on private registries and external donor networks. The absence of an indigenous donor pool increased dependence on external mechanisms for donor search and matching, leading to higher

costs, longer waiting periods, and reduced accessibility for economically vulnerable patients requiring transplantation.

3.3.K-DISC's Intervention

K-DISC, in collaboration with Malabar Cancer Centre (MCC), Thalassery, supported the implementation of the Kerala Bone Marrow Registry (KBMR) to strengthen stem cell donor management and improve access to bone marrow transplantation services in Kerala. The intervention focuses on the development of a centralized web-based Bone Marrow Registry to digitize donor registration, patient registration, donor–patient matching, transplantation workflows, and post-donation follow-up processes.

The proposed platform is designed to incorporate standardized donor matching mechanisms aligned with globally accepted World Marrow Donor Association (WMDA) practices to support efficient and accurate donor identification for patients requiring transplantation. The intervention also envisions integration with WMDA networks and relevant healthcare systems to strengthen donor search interoperability and transplant-related coordination.

3.4. Technology Architecture and Key Functional Components

The proposed Kerala Bone Marrow Registry (KBMR) was designed as a centralized web-based digital healthcare platform to support donor identification, patient registration, HLA matching, and transplant coordination. The platform was proposed to be hosted at the Kerala State Data Centre (SDC) with integration support for eHealth Kerala, Kerala Cancer Registry, and World Marrow Donor Association (WMDA) systems.

1. **Donor and Patient Registration Module**

The system included dedicated digital modules for donor and patient registration, integrated with UHID/ABHA ID and eHealth Kerala APIs. The module was designed to support centralized creation and management of donor and patient records, including retrieval and validation of demographic information from existing healthcare systems.

2. **Collection Centre Module**

The Collection Centre Module was intended for use by Advanced Blood Collection Centres to support activities related to donor registration, sample collection, barcode-based sample tracking, HLA testing workflows, donor follow-up, and donor status management. The module was also designed to maintain demographic details, infectious disease screening markers, HLA typing results, stem cell collection information, and audit trails.

3. Transplant Centre Module

The Transplant Centre Module supported patient registration, donor search requests, preliminary donor matching, confirmatory testing workflows, transplant documentation, and patient follow-up activities. The module also enabled maintenance of transplant-related medical information and donor reservation status.

4. Patient–Donor Matching Engine

The system architecture incorporated a Patient–Donor Matching Engine based on World Marrow Donor Association (WMDA) HLA matching principles to support identification of compatible donors. The module was intended to facilitate preliminary donor matching, compatibility assessment, and donor search optimization.

5. Artificial Intelligence and Machine Learning Components

The proposed platform included Artificial Intelligence (AI) and Machine Learning (ML)-based analytical components intended to support transplant success prediction, post-transplant risk assessment, and analytical support for donor matching workflows.

6. API Integration Framework

The architecture proposed API-based integration with systems such as eHealth Kerala, Kerala Cancer Registry, HLA laboratories, and WMDA-related workflows to support donor and patient registration, laboratory result retrieval, transplant status updates, and synchronization of healthcare records.

7. Public Dashboard and Reporting System

The platform included provisions for dashboard and reporting mechanisms to support monitoring of donor registrations, transplant workflows, donor availability, matching activities, and programme-level reporting for healthcare administrators and institutions.

8. Security and Infrastructure Architecture

The KBMR platform was proposed to be deployed through a centralized infrastructure at the Kerala State Data Centre (SDC) with provisions for secure data storage, role-based access control, audit trails, and protected access to sensitive patient and donor information.

3.5. Stakeholders

#	Stakeholder	Role and Contribution
1	Health & Family Welfare Department, Government of Kerala	Provided administrative and institutional support for pilot implementation of the project and facilitated healthcare system coordination activities.
2	eHealth Kerala	Supported the project through API provisioning, UHID/ABHA integration, interoperability support, and integration with existing Government healthcare information systems.
3	Malabar Cancer Centre (MCC), Thalassery	Functioned as the nodal clinical institution and provided domain expertise related to bone marrow transplantation workflows, HLA matching, donor management, and transplant protocols.
4	Collection Centres	Proposed to support donor registration, sample collection, barcode-based tracking, donor follow-up, and coordination with testing laboratories.
5	Transplant Centres	Responsible for patient registration, donor search initiation, confirmatory testing coordination, transplant workflows, and patient follow-up management.
6	World Marrow Donor Association (WMDA)	Proposed integration partner to support interoperability and donor search across international donor registries and databases.

Table 15: Stakeholders- Kerala Bone Marrow Registry

3.6. Pilot Location

The pilot implementation of the Kerala Bone Marrow Registry (KBMR) was proposed to be coordinated through Malabar Cancer Centre (MCC), Thalassery, under the Health & Family Welfare Department, Government of Kerala, considering its role as a major centre for Bone Marrow Transplantation (BMT) and related clinical services in the State.

The implementation framework also proposed progressive integration of Advanced Blood Collection Centres and Transplant Centres across Kerala into the registry platform to support donor registration, HLA testing, donor matching, and transplant coordination workflows.

3.7. Expected Benefits

- Improved probability of identifying suitable stem cell donors through a centralized and searchable donor registry.
- Reduced time and operational complexity in donor identification and matching, supporting timely transplantation for patients.
- Improved affordability and accessibility of donor matching services by reducing dependence on costly external registries.
- Enhanced efficiency through digitization of donor and patient registration workflows, reducing manual documentation and duplication.
- Strengthened interoperability with national and international donor ecosystems through integration with WMDA-compatible workflows.
- Improved continuity of care through structured donor and patient follow-up after stem cell donation and transplantation.
- Enhanced monitoring, reporting, and programme management through automated reporting and centralized data availability.
- Better coordination among collection centres, transplant centres, and healthcare institutions involved in transplantation workflows.

4. Integrated Healthcare Delivery System

4.1. Problem Statement

Despite Kerala's strong healthcare indicators, the healthcare delivery ecosystem remains fragmented, resulting in challenges related to timely consultations, diagnostics, emergency response, medicine access, and continuity of care. Patients often face difficulties in navigating healthcare services across multiple institutions and digital platforms, while healthcare providers lack seamless interoperability and real-time coordination mechanisms.

The increasing burden of non-communicable diseases (NCDs), ageing population, rising healthcare demand, and out-of-pocket expenditure further strain the healthcare system. Although several digital health initiatives such as eHealth, DISHA, teleconsultation platforms, and ambulance services are operational, these systems largely function independently without an integrated care coordination framework.

This highlighted the need for a unified and technology-enabled Integrated Healthcare Delivery System (IHCD) to connect healthcare services, streamline patient navigation, improve continuity of care, and enable coordinated, data-driven healthcare delivery across Kerala.

4.2. Existing Challenges

Kerala's healthcare ecosystem comprises multiple institutions, service providers, and digital health platforms operating across different levels of care. However, the absence of an integrated coordination framework created operational challenges in service delivery, patient navigation, continuity of care, and healthcare management.

A major challenge was the limited interoperability between healthcare systems and digital platforms, affecting seamless information exchange and coordinated service delivery. Delays were often experienced in coordinating consultations, diagnostics, ambulance services, referrals, and medicine delivery, affecting timely access to care and patient experience.

Another key challenge was the lack of efficient referral, follow-up, and patient tracking mechanisms across healthcare institutions, making it difficult to monitor patient journeys and ensure continuity of care, particularly for chronic disease management and long-term treatment pathways.

Further, healthcare institutions had limited real-time visibility into healthcare resource availability and service utilization, affecting operational planning and responsiveness. The fragmented nature of healthcare workflows also constrained integration of public health schemes, frontline worker services, and patient support systems, while limiting opportunities for centralized monitoring, analytics, and data-driven decision-making.

These disconnected systems and manual coordination processes increased the operational burden on healthcare institutions, affecting efficiency and coordinated healthcare delivery.

1. K-DISC's Intervention

The K-DISC conceptualized the Integrated Healthcare Delivery System (IHCD) as a patient-centric and integrated healthcare delivery model to strengthen coordination, continuity, and accessibility of healthcare services across Kerala. The intervention focused on developing a high-level integrated digital healthcare framework, aligned with the Ayushman Bharat Digital Mission (ABDM), to address fragmentation in healthcare delivery and improve interoperability across healthcare systems.

The proposed intervention envisaged integration of existing healthcare platforms and services, including eHealth, DISHA, teleconsultation systems, ambulance services, diagnostics, drug supply chain systems, and Electronic Health Records (EHRs), into a unified digital healthcare ecosystem.

The approach emphasized leveraging existing digital infrastructure while enabling integration of new healthcare applications and services as required.

The intervention aimed to support integrated healthcare service delivery, real-time care coordination, patient navigation, continuity of care across healthcare levels, and data-driven monitoring and decision-making. It also proposed a common digital framework to facilitate integration of existing and future Emerging Technology (ET) healthcare initiatives within the State's healthcare ecosystem.

4.3. Technology Architecture and Key Functional Components

The Integrated Healthcare Delivery System (IHCD) proposes a technology-enabled and interoperable digital healthcare architecture to support integrated, patient-centric healthcare delivery across Kerala. The framework is designed to strengthen care coordination, interoperability, continuity of care, and data-driven healthcare management through integration of existing and future digital health systems.

1. **Integrated Digital Health Architecture:**

A unified digital architecture is proposed to enable interoperability and scalable integration across healthcare institutions, digital platforms, and service providers operating at different levels of care.

2. **Electronic Health Records (EHR) and Health Information Exchange (HIE):**

The framework envisages integration of Electronic Health Records (EHRs) and Health Information Exchange (HIE) systems to support continuity of care, secure sharing of patient health information, and seamless access to medical records across healthcare providers.

3. **API-Based System Integration and Consent Management:**

The proposed system incorporates API-based interoperability mechanisms and patient consent management frameworks, aligned with Ayushman Bharat Digital Mission (ABDM) standards, to facilitate secure and authorized exchange of health information.

4. **AI-Enabled Patient Assessment and Decision Support:**

The architecture proposes Artificial Intelligence (AI)-enabled patient assessment and clinical decision-support systems to support risk-based triaging, intelligent patient navigation, healthcare recommendations, and informed decision-making.

5. **Real-Time Dashboards and Analytics Platform:**

The initiative includes real-time monitoring dashboards and analytics systems to support healthcare governance, service monitoring, operational visibility, healthcare planning, and data-driven decision-making.

6. **Intelligent Patient Screening and Predictive Healthcare Systems:**

The framework proposes predictive healthcare and intelligent screening systems to support early identification of health risks, disease surveillance, preventive interventions, and proactive healthcare delivery.

7. **Digital Care Coordination and Workflow Management:**

A coordinated digital workflow system is proposed to support consultations, referrals, diagnostics, ambulance services, medicine delivery, follow-up care, and patient navigation, enabling continuity of care across primary, secondary, and tertiary healthcare institutions.

8. **Cloud-Based Digital Infrastructure:**

A scalable cloud-enabled digital infrastructure is proposed to support centralized hosting, secure system management, and statewide scalability of healthcare services and digital applications.

9. **Public Health Surveillance and Monitoring Systems:**

The framework includes data-driven public health surveillance and monitoring systems to strengthen healthcare intelligence, epidemiological monitoring, policy planning, and evidence-based decision-making.

10. **Integration of Emerging Technology (ET) Health Projects:**

The proposed ecosystem is designed to enable seamless integration of existing and future Emerging Technology (ET) healthcare initiatives under a common and interoperable digital healthcare framework.

4.4. Stakeholders

#	Stakeholder	Role and Contribution
1	Department of Health & Family Welfare, Government of Kerala	Provides overall administrative, policy-level, and institutional support for implementation of the Integrated Healthcare Delivery System (IHCD).
2	Kerala Development and Innovation Strategic Council (K-DISC)	Functions as the conceptualization, coordination, and technical support agency for development and implementation of the IHCD framework and Proof of Concept (PoC).
3	State Digital Health Mission (SDHM)	Supports alignment of the initiative with digital health standards and implementation frameworks under the Ayushman Bharat Digital Mission (ABDM).
4	Directorate of Health Services (DHS)	Supports integration of healthcare delivery systems and implementation across primary and secondary healthcare institutions.
5	Directorate of Medical Education (DME)	Facilitates integration and implementation within tertiary care and medical education institutions.
6	National Health Mission (NHM)	Supports healthcare programme integration, coordination, and alignment with public health initiatives.
7	eHealth Kerala	Provides digital health platform integration and supports interoperability with existing healthcare systems and electronic health records.
8	DISHA Call Centre	Supports citizen engagement, patient navigation, and healthcare-related information services within the integrated care framework.
9	Kerala Medical Services Corporation Limited (KMSCL)	Facilitates integration of medicine procurement, supply chain, and related healthcare logistics systems.

10	Public and Private Healthcare Institutions	Function as implementation and service delivery institutions across different levels of care.
11	Frontline Healthcare Workers and Field-Level Health Teams	Support community-level healthcare delivery, screening, patient follow-up, and care coordination activities.
12	Local Self Government Institutions (LSGs)	Facilitate local-level coordination and support implementation of public health and community healthcare initiatives.
13	Technology Partners, Implementation Agencies, and CSR Partners	Support development, implementation, technical integration, and scaling of digital healthcare solutions.
14	Citizens and Healthcare Beneficiaries	Function as the primary end users and beneficiaries of integrated healthcare services under the IHCD framework.

Table 16: Stakeholders- IHCD

The initiative also involves stakeholder consultations, expert committees, and interdepartmental coordination mechanisms to support phased implementation and scale-up of the Integrated Healthcare Delivery System.

4.5. Pilot Location

The Integrated Healthcare Delivery System (IHCD) Care Coordination- the process level pilot was implemented in a phased manner across selected health blocks in Thiruvananthapuram district to assess the feasibility of coordinated patient navigation and referral management across different levels of healthcare.

During Phase 1, the pilot was initiated in the Perumkadavila and Vellarada Health Blocks, covering 12 healthcare institutions, including linkages with tertiary care facilities. Phase 2 expanded the pilot to the Vamanapuram, Vithura, Kanyakulangara, and Vellanad Health Blocks, extending coverage to 17 additional healthcare institutions. Subsequently, Phase 3 further expanded implementation to 114 institutions across Thiruvananthapuram district.

As of December 2025, nearly 150 healthcare institutions in the district had initiated referral coordination and patient navigation activities under the IHCD care coordination pathway.

Based on the progress observed during the pilot, the Government approved expansion of the IHCD Care Coordination Pilot to all districts in Kerala, initially covering one Health Block in each district.

1. Outcomes / Observations

The IHCD Care Coordination Pilot demonstrated improvements in patient navigation, referral coordination, and continuity of care through integration of existing public health systems and digital platforms. The pilot enabled structured referral pathways and coordinated patient movement across healthcare institutions, supporting more seamless access to healthcare services.

More than 6,000 patients were navigated through assured appointments and coordinated referral mechanisms, indicating improved access to care and strengthened referral management across participating institutions. The implementation also contributed to increased adoption of eHealth-based referral tracking and care coordination workflows, improving visibility and coordination between healthcare facilities.

Regular monitoring, stakeholder coordination, and institutional review mechanisms strengthened implementation and supported continuous refinement of workflows based on field-level experience. The pilot further demonstrated the potential for better utilization of existing healthcare infrastructure and resources without significant additional manpower requirements.

Overall, the pilot indicated the operational feasibility of scaling the care coordination model across healthcare institutions in Kerala.

4.6. Expected Benefits

The Integrated Healthcare Delivery System (IHCD) is expected to strengthen healthcare service delivery through improved care coordination, patient navigation, and integration of existing healthcare systems and resources.

Key expected benefits include:

- Improved access to healthcare services through coordinated referral and appointment management.
- Enhanced continuity of care across primary, secondary, and tertiary healthcare institutions.
- Reduced patient waiting time and improved healthcare experience.
- Better utilization of existing healthcare infrastructure, workforce, and digital platforms.
- Strengthened coordination between healthcare providers and institutions.
- Improved visibility and monitoring of patient journeys through digital tracking mechanisms.

- Increased efficiency in healthcare service delivery and resource management.
- Data-driven decision-making through real-time monitoring and analytics.
- Reduced fragmentation in healthcare delivery through integrated workflows and systems.
- Scalable care coordination model that can be expanded across the State.

CHAPTER 5. Strategic Roadmap

Based on the implementation experience of emerging technology initiatives in the healthcare sector, a structured and phased approach is required to strengthen technology-enabled healthcare delivery across Kerala. The strategic roadmap focuses on improving healthcare accessibility, interoperability, scalability, continuity of care, and evidence-based decision-making through coordinated adoption of digital and emerging technologies.

a. Strengthening Digital Health Integration

Future healthcare initiatives may focus on strengthening interoperability between existing digital health platforms, including eHealth Kerala, Electronic Health Records (EHR), referral systems, teleconsultation platforms, diagnostics, and citizen-facing healthcare applications to enable seamless care coordination and integrated healthcare delivery.

b. Scaling Proven Pilot Initiatives

Technology pilots demonstrating operational feasibility and positive outcomes may be considered for phased scale-up across healthcare institutions, supported by structured evaluation, workflow standardization, and institutional readiness assessments.

c. **Advancing Artificial Intelligence in Healthcare**

There is potential to strengthen the adoption of Artificial Intelligence (AI)-enabled healthcare solutions in areas such as screening, diagnostics, clinical decision support, predictive analytics, patient navigation, and operational efficiency, supported by clinically validated datasets and governance frameworks.

d. Strengthening Healthcare Data Governance and Security

Future digital healthcare systems may prioritize secure health data exchange, privacy protection, consent management, and compliance with national digital health standards, ensuring trusted and secure use of healthcare information.

e. Enhancing Citizen-Centric Healthcare Services

Technology-enabled interventions may focus on improving citizen experience and healthcare accessibility through integrated digital services, multilingual support systems, care coordination mechanisms, and improved patient navigation.

f. Strengthening Capacity Building and Change Management

Sustained adoption of emerging technologies in healthcare will require continued capacity building, stakeholder sensitization, technical training, and institutional handholding support for healthcare professionals and administrators.

g. **Promoting Innovation Ecosystem and Public–Private Collaboration**

Future healthcare innovation may be strengthened through continued collaboration among government departments, healthcare institutions, startups, academia, and technology partners, enabling faster validation, implementation, and scaling of innovative healthcare solutions.

h. Evidence-Based Scale-Up and Monitoring

Future expansion of healthcare initiatives may be guided by pilot outcomes, clinical evidence, implementation learnings, and periodic monitoring mechanisms to ensure effectiveness, sustainability, and alignment with healthcare priorities.

The healthcare initiatives undertaken demonstrate the potential of emerging technologies to strengthen public healthcare delivery, improve accessibility, enhance care coordination, and support data-driven healthcare management. Continued collaboration, institutional readiness, and evidence-based implementation will be critical in enabling sustainable and scalable healthcare transformation across Kerala.

Acknowledgement

The Department of Health and Family Welfare in partnership with K DISC took initiatives to tap into the very latest of technologies like employing Block Chains, Artificial Intelligence, Robotics etc. The initiatives to do Blood bag traceability, carcinoma cervix, diabetic retinopathy were the first batch of interventions. Subsequently, a hackathon was conducted to identify relevant interventions.

All these initiatives would not have been possible without the guidance and encouragement from Dr K M Abraham. I express my sincere gratitude to Sir. Further, Prof Unnikrishnan has facilitated the initiatives. We are thankful to him.

Ms Deepthy Mohan, Dr Nimmy and her team have shown keen interest to take many initiatives. Her constant follow up ensured that these ideas are taken forward to the next level. Recently, the Blood Bag Traceability project received national level recognition. I am confident that all the other projects in their implementation stage, will get the same recognition. The most important thing that these initiatives achieved is to trigger forward-thinking among health fraternities regarding health technology. The Malabar Cancer Centre established an innovation cell and there are a few start-ups doing proof of concept. We wholeheartedly congratulate Ms Deepthy and her team for facilitating and supporting the Health Department.

I expressed sincere thanks to all my colleagues Dr Ravi, Dr Vishwanthan, Dr Mahes, Dr Ajan, Dr Vinay, Mr Rahul, Ms Sinu and many others who relentlessly worked to complete the projects.

Now, Dr Vishwanathan Director Medical Education has taken an initiative to establish Innovation and Entrepreneur Development Cell in all Government Medical Colleges. It will give impetus to the health tech initiatives in the State.

I wish all the success for the future initiatives in Health tech space.

Dr Rajan Khobragade IAS

Addl Chief Secretary

Health and Family Welfare

Govt of Kerala

**********End of the Document**********