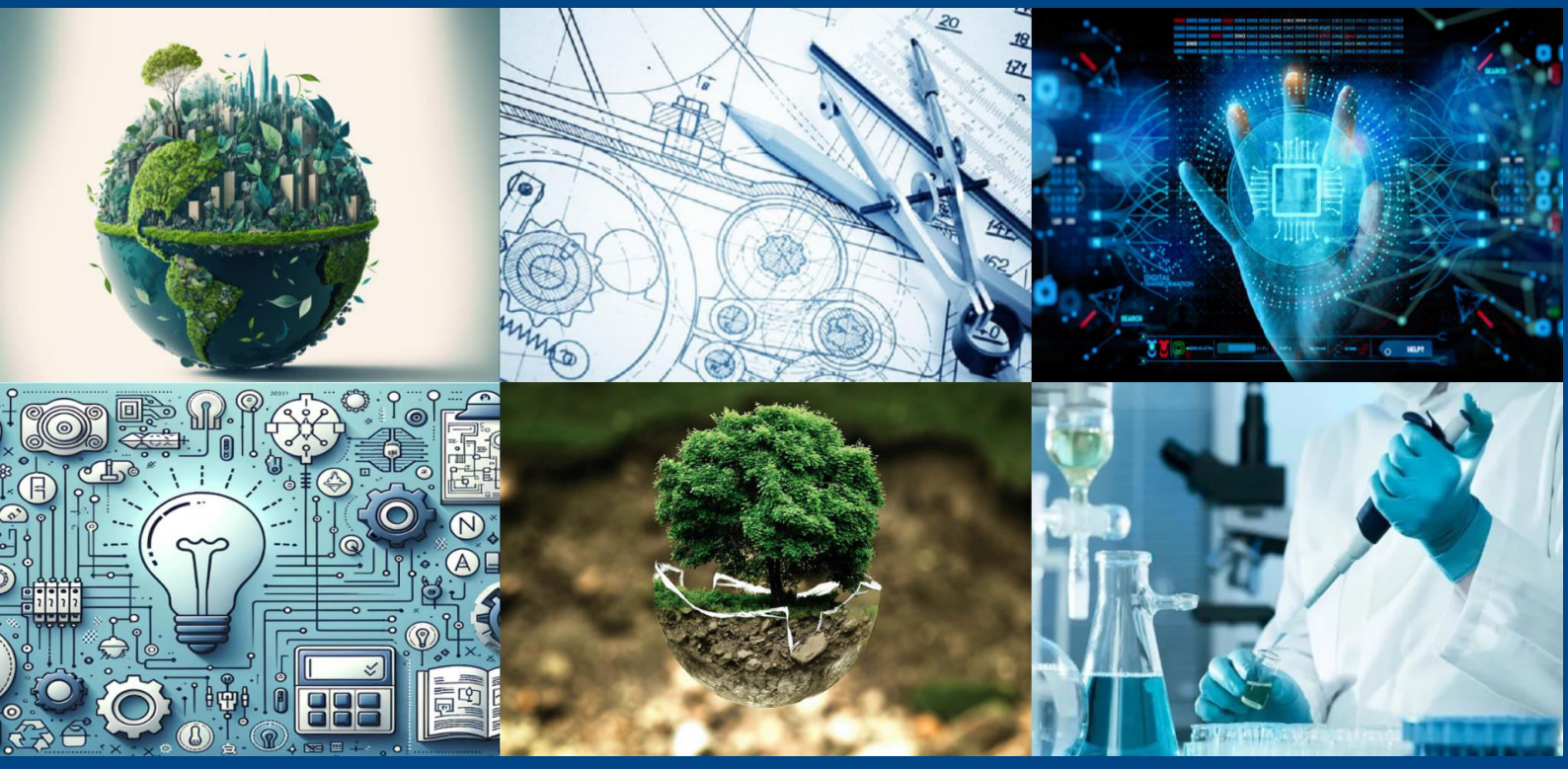
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 8, Issue 5, May 2025

© 2025 IJMRSET | Volume 8, Issue 5, May 2025| DOI:10.15680/IJMRSET.2025.0805066

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Care Free: An Open-Source Digital Public Health Infrastructure for Decentralized Healthcare Delivery in India

Celina Sagore, Navansh Dang, Prof. Geeta Santhosh

Scholar, Department of Computer Application, Acropolis Institute of Technology and Research, Indore, India

Scholar, Department of Computer Application, Acropolis Institute of Technology and Research, Indore, India

Department of Computer Application, Acropolis Institute of Technology and Research, Indore, India

ABSTRACT: The COVID-19 pandemic revealed critical limitations in healthcare accessibility, infrastructure, and digital preparedness across various nations. In India, where geographical disparities and resource constraints exacerbate health inequities, Care Free emerged as a transformative digital public good. This paper explores the genesis, technological underpinnings, and socio-political impact of Care Free—an open-source frontend platform designed to support TeleICU operations, facility management, and decentralized healthcare governance. The study discusses its modular architecture, public health implications, scalability, role in telemedicine, and potential as a replicable model in other developing nations.

I. INTRODUCTION

1.1 Background and Relevance

The pandemic's global disruptions underscored the need for adaptive, real-time, and decentralized health information systems. India, with its vast population and layered administrative structure, faced a critical bottleneck: while backend data existed in silos, there was no effective public-facing, role-driven, or mobile-accessible platform to manage ICU admissions, ventilator status, or oxygen demand.

Care Free, developed as part of the broader CARE platform (COVID-19 Assistance and Response), was launched as the **frontend interface** to solve this problem. It empowered healthcare providers, government officials, and field workers with real-time data dashboards, patient monitoring tools, and triage support.

1.2 Digital Public Infrastructure and Open Source in Healt

Globally, the momentum toward **Digital Public Infrastructure (DPI)** and **Digital Public Goods (DPGs)** has grown. Care Free aligns closely with these paradigms, offering a reusable, government-grade technology that serves citizens, scales effortlessly, and promotes interoperability. It is licensed under MIT, making it available to any state, district, or country that wants to adopt it.

II. OBJECTIVES OF THE CARE FREE PLATFORM

Care Free is not just a software interface—it is an enabler of decentralized governance. Its primary goals include:

- **Decentralized Decision-Making**: Empower district-level health workers with autonomy while maintaining centralized oversight.
- **TeleICU Enablement**: Bridge urban-rural gaps by facilitating video consultations and remote ICU operations.
- **Real-Time Data Visibility**: Make critical information about ICU beds, oxygen supplies, and human resources publicly accessible.
- **Multilingual and Inclusive Design**: Ensure access for users of varying tech literacy across different languages and devices.
- **Rapid Deployment and Customization**: Allow for fast, modular rollouts in crisis zones and evolving health contexts.

© 2025 IJMRSET | Volume 8, Issue 5, May 2025| DOI:10.15680/IJMRSET.2025.0805066

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

III. TECHNOLOGICAL FRAMEWORK AND ARCHITECTURE

Frontend Stack

Care Free uses React with Vite for rapid development and performance. TypeScript provides strong typing, and Tailwind CSS ensures a consistent, responsive design system. State management is handled via React Context API, and data fetching uses libraries like SWR and React Query.

Modularity and Performance

The application is modular with feature-based folders such as FacilityDashboard and TeleICU. Each module can be deployed independently based on regional requirements. Lazy loading, tree-shaking, and asset optimization ensure that the app is performant even in low-bandwidth environments.

DevOps

GitHub Actions powers CI/CD with automated testing, linting, and Docker-based deployments. Static builds are deployed on platforms like Netlify or Vercel, depending on the region.

IV. FEATURE BREAKDOWN AND USER JOURNEYS

Care Free offers a broad spectrum of features tailored to different stakeholders in the public health ecosystem. These features not only improve real-time visibility but also facilitate smoother coordination, better clinical decision-making, and efficient resource allocation.

4.1 Role-Based Interface Customization

Care Free provides tailored interfaces for five key user groups:

- **State Admins:** Full control over hospitals, facilities, district hierarchies, user access, and TeleICU routing rules. They can configure state-specific workflows and monitor macro-level trends across districts.
- **District Admins:** Limited access to their jurisdiction. They monitor hospital loads, oxygen consumption, referral patterns, and can trigger escalation alerts when facilities reach critical thresholds.
- **Facility Staff:** Typically hospital administrators or data entry operators. They update ward-level statistics, add new patient cases, and input data like ventilator usage, bed availability, and medicine stock.
- **Field Workers:** Community health workers or emergency response teams use mobile interfaces to log case details, conduct on-site triage, and refer patients to appropriate facilities.
- **Doctors:** Especially in the TeleICU module, doctors view live patient data, submit consult notes, escalate cases, or mark discharges.

4.2 Real-Time Health Infrastructure Monitoring

The **TeleICU module** is a core differentiator. It allows doctors at tertiary hospitals to provide critical care remotely. Key functionalities include:

- Live viewing of patient summaries (including temperature, blood pressure, oxygen saturation) Integration with device telemetry (where available)
- History of clinical observations and interventions
- Chat or video consult feature with local health teams
- Handoff notes and escalation status for transfers

This feature proved vital during COVID surges when Tier 1 cities provided ICU support to Tier 2 and 3 facilities via Care Free.

4.3 Facility Dashboards

Every registered facility receives its own dashboard showing:

- Ward-level occupancy (ICU, O2, Non-O2 beds)
- Human resource status (e.g., doctor, nurse shifts).
- Medical asset logs (e.g., working ventilators, oxygen levels)
- Isolation/quarantine zone reports
- Recent discharges and admission counts

© 2025 IJMRSET | Volume 8, Issue 5, May 2025| DOI:10.15680/IJMRSET.2025.0805066

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

The dashboard supports advanced filters (by time, region, resource) and has graphical representations to support planning decisions.

4.4 Reporting and Analytics

Admins can generate:

- Daily Situation Reports (SITREPs)
- Oxygen demand forecasts
- Human resource deployment audits
- Exportable CSVs for third-party data pipelines

The system is designed for API-based report generation so that states can integrate Care Free into their health ministry's data warehouses or dashboards.

V. REAL-WORLD DEPLOYMENT

Care Free has been deployed across nine Indian states. Each deployment was adapted to local administrative hierarchies and languages. During COVID-19, it helped manage 120,000+ patients across thousands of facilities. The system supported real-time decisions that reduced ICU referral time by over 50%.

Offline-first capabilities enabled continued data entry in low-connectivity regions. Local language support and simple UI empowered field workers with minimal digital training

VI. CHALLENGES AND MITIGATION STRATEGIES

Implementing a digital health infrastructure like Care Free in a diverse and populous country like India presents several challenges. Addressing these effectively is crucial for the platform's success and sustainability.

6.1 Technological Challenges

Infrastructure Variability: Many healthcare facilities, especially in rural areas, lack consistent internet connectivity and modern hardware.

Mitigation: Care Free is designed with an offline-first approach, allowing data entry and storage locally, which synchronizes with central servers once connectivity is restored.

Device Compatibility: The diversity of devices used across facilities can lead to compatibility issues**.**

Mitigation: The platform employs responsive design principles and is tested across various devices and browsers to ensure broad compatibility.

6.2 Human Resource Challenges

Training and Adoption: Healthcare workers may have limited experience with digital tools, leading to resistance or errors in usage.

Mitigation: Comprehensive training programs, including hands-on workshops and user manuals in local languages, are provided to facilitate smooth adoption.

Staff Turnover: High turnover rates can result in a loss of trained personnel.

Mitigation: Continuous training modules and a train-the-trainer approach ensure knowledge transfer and retention within the system.

6.3 Data Management Challenges

Data Accuracy and Timeliness: Ensuring that data entered is accurate and up-to-date is critical for effective decision-making.

Mitigation: The platform includes validation checks, mandatory fields, and real-time dashboards to monitor data quality and prompt timely updates.

Privacy and Security: Handling sensitive patient data necessitates stringent privacy and security measures.

Mitigation: Care Free adheres to data protection regulations, employing encryption, role-based access controls, and regular security audits to safeguard information.

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

VII. PUBLIC HEALTH IMPACT

- Real-time situational awareness across states
- Faster decision-making and reduced escalation times
- Remote ICU consultations enabled equitable critical care
- Improved transparency and accountability in public health governance

VIII. COMPLIANCE WITH DIGITAL PUBLIC GOODS (DPG) STANDARDS:

Care Free is open-source under the MIT License and aligns with DPG standards through:

- Open documentation
- Adherence to global health data standards (e.g., FHIR)
- Privacy-first design
- Community collaboration and localization

IX. FUTURE ENHANCEMENTS

To further its mission of improving healthcare delivery, Care Free is exploring several enhancements:

9.1 Artificial Intelligence Integration

- **Predictive Analytics:** Implementing AI to forecast healthcare demands and resource needs, enabling proactive management. **Clinical Decision Support:** Developing AI-driven tools to assist healthcare providers in diagnosis and treatment planning.

9.2 Expanded Telehealth Services

- Enhancing teleconsultation features to cover a broader range of specialties and services, increasing access to care in underserved areas.

9.3 Community Health Initiatives

- Integrating modules for maternal and child health, immunization tracking, and chronic disease management to support comprehensive community health programs.

9.4 Global Collaboration

- Collaborating with international organizations to adapt Care Free for use in other countries, sharing best practices and technological advancements.

X. CONCLUSION

Care Free exemplifies the transformative potential of open-source digital tools in enhancing healthcare delivery. By addressing critical challenges in resource management, data accessibility, and healthcare coordination, the platform has become an integral part of India's public health infrastructure. Its alignment with Digital Public Goods standards positions it as a model for global health initiatives, demonstrating how technology can bridge gaps in healthcare access and quality. As Care Free continues to evolve, its commitment to innovation, inclusivity, and collaboration will be pivotal in shaping resilient and equitable healthcare systems worldwide.

REFERENCES

1. Balsari, S., Sangeeta, R., & Sneh, B. (2018). *Reimagining Health Data Exchange: An Application Programming Interface–Enabled Roadmap for India*. Journal of Medical Internet Research, 20(7), e10725. https://doi.org/10.2196/10725
2. Ministry of Health and Family Welfare, Government of India. (2021). *Ayushman Bharat Digital Mission (ABDM): Strategy Overview*. National Health Authority. https://abdm.gov.in
3. Rathi, A., & Shukla, S. (2022). *Implementing National Digital Health Blueprint in India: Future Opportunities and Challenges*. International Journal of Preventive Medicine, 13, 80. https://doi.org/10.4103/ijpvm.IJPVM_661_21
4. Kumar, A., & Sharma, N. (2024). *Advancements and Challenges in Digital Health Implementation in India: A Comprehensive Literature Review*. World Journal of Biology Pharmacy and Health Sciences, 6(2), 21–31. https://repository-wjbphs.com/content/wjbphs-2024-0186
5. Singh, M., & Das, R. (2024). *Digital Governance in Transforming Health Systems and Health Policy in India*. Journal of Community Health Management, 11(1), 42–47. https://doi.org/10.18231/j.jchm.2024.008
6. Open Healthcare Network. (2023). *CARE: A Public Digital Good for Pandemic Response and Beyond*. https://ohc.network/care
7. National Health Authority. (2020). *National Digital Health Blueprint*. Government of India. https://nha.gov.in/ndhb

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com