Re-Engineering Digital Public Welfare Systems in India: A Ground-Level Socio-Technical Case for Inclusive and Resilient Governance

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I. INTRODUCTION

India's digital transformation has increasingly changed the way public services and welfare programmes are planned, administered, and delivered. Over the last decade, digital platforms have become an important part of public administration, particularly in areas such as food security, financial inclusion, healthcare, education, and agricultural (NITI Aayog, 2022; Ministry of Electronics and Information Technology, 2023). marketing. Initiatives such as the Aadhaar-enabled Public Distribution System (PDS), Direct Benefit Transfer (DBT), CoWIN, DIKSHA, and the National Agriculture Market (eNAM) illustrate how digital technologies are being integrated into welfare and service-delivery mechanisms. These platforms rely on digital identity, cloud-based infrastructure, databases, application programming interfaces (APIs), online authentication, and data-processing systems to support service delivery at a large scale.

From a technological and engineering perspective, these systems offer several advantages. Digital platforms can process large volumes of information, support real-time transactions, reduce dependence on paper-based processes, and provide mechanisms for monitoring and tracking service delivery. Centralized databases and cloud-supported applications can also allow information to be exchanged between different administrative levels and service points. In principle, this creates a more transparent and efficient system in which welfare benefits can reach intended beneficiaries with fewer procedural delays and reduced opportunities for duplication or leakage. However, the performance of a digital welfare system cannot be assessed only by examining its backend infrastructure or the number of transactions processed. The actual effectiveness of such systems becomes visible at the point where a citizen interacts with the service. A technically advanced platform may perform efficiently at the server or application level but still create difficulties for users when the last-mile infrastructure is weak. This distinction is particularly important in rural and semi-urban areas, where internet connectivity, availability of digital devices, digital literacy, electricity supply, and access to assisted service centres may vary considerably. For example, an authentication-based welfare service may require a stable internet connection and successful biometric verification. When connectivity is poor or authentication fails, the technical capability of the central system does not necessarily translate into successful service delivery. Similarly, a digital platform designed primarily for smartphone-based access may be difficult to use for households that have limited access to personal devices or depend on a shared mobile phone. In such situations, the issue is not necessarily the absence of technology; rather, it is the mismatch between system requirements and the conditions under which people are expected to use the

system. This distinction becomes particularly important when digital welfare systems are examined from the perspective of Human Development and Family Studies (HDFS). Welfare services are rarely experienced as isolated technological transactions. Their consequences extend to the household and may influence food security, health, education, income stability, time use, and overall family well-being. A delay in receiving subsidized food grains can affect household nutrition. Difficulty in accessing a financial transfer can increase the time and cost involved in meeting essential expenses. Similarly, unequal access to digital educational content can affect learning continuity among children from households with limited devices or internet connectivity.

Therefore, the effectiveness of digital welfare delivery should be understood through a broader socio-technical framework. Such a framework recognizes that technology, policy, infrastructure, service providers, and users are interconnected. A welfare platform may be technically sound, but its final outcome depends on whether the complete chain—from the central digital infrastructure to the local service point and ultimately to the household—functions effectively.

The present case study therefore examines selected digital welfare systems in India by moving beyond a purely technology-centred assessment. The analysis considers five platforms—Aadhaar-enabled PDS, DBT, CoWIN, DIKSHA, and eNAM—and examines how their intended benefits are experienced at the ground level. Particular attention is given to recurring issues such as biometric authentication problems, network instability, limited device access, digital literacy gaps, dependence on intermediaries, and difficulties in navigating digital interfaces.

The study also considers the difference between individual-level access and household-level outcomes. A digital service may be technically available to a beneficiary, but actual access can still be constrained by travel requirements, waiting time, transaction failure, lack of awareness, or dependence on another person for completing the process. These factors create what may be described as a gap between system availability and effective access.

Accordingly, the central concern of this study is not whether India has successfully adopted digital technologies for welfare delivery, but whether these technologies remain accessible, usable, and resilient under real-world conditions. The study seeks to understand how digital welfare systems function when they encounter the practical realities of rural and semi-urban households and how these realities influence human development outcomes.

The study further proposes an Integrated Rural Digital Support Ecosystem (IRDSE) as a conceptual framework for addressing these challenges. The proposed approach combines existing cloud infrastructure with localized digital access, assisted service delivery, edge-level support, and hybrid online-offline mechanisms. The objective is not to replace existing welfare platforms but to strengthen the connection between these platforms and the people who depend upon them.

In this context, the study adopts a simple but important perspective: the success of digital governance should ultimately be measured not only by how efficiently a system operates, but also by how reliably it serves people under the conditions in which they actually live.

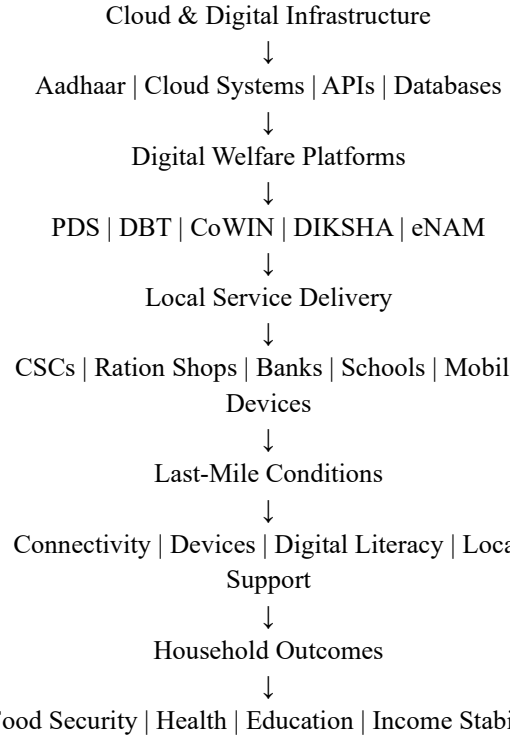

Figure 1: Digital Welfare Delivery: From Digital Infrastructure to Household Outcomes

Figure explanation: The framework shows that the effectiveness of digital welfare delivery is determined

by more than the technical capacity of cloud-based systems. Although centralized infrastructure and digital platforms provide the technological foundation for large-scale service delivery, the final outcome depends on the availability of local service interfaces and the ability of households to access and use them. Connectivity limitations, device constraints, digital literacy, and dependence on intermediaries may therefore create a gap between system capability and actual household-level outcomes. This is the central socio-technical concern examined in the study.

II. OBJECTIVES OF THE STUDY

The present study aims to examine the functioning of digital welfare systems in India from a ground-level and socio-technical perspective. While digital platforms have been developed to improve the efficiency, transparency, and reach of public welfare programmes, their actual effectiveness depends on the conditions under which people access and use these services. The study therefore focuses on the relationship between technological design, service delivery mechanisms, and household-level outcomes. The specific objectives of the study are as follows:

2.1 To examine the functioning of cloud-enabled public welfare systems at the ground level

The first objective is to understand how selected digital welfare platforms operate in everyday conditions, particularly in rural and semi-urban settings. The study considers Aadhaar-enabled PDS, DBT, CoWIN, DIKSHA, and eNAM as representative cases and examines how the intended digital service-delivery process translates into actual access for users.

2.2 To assess the relationship between digital access and household well-being

The second objective is to examine how access to digital welfare services influences household-level well-being. The study considers outcomes related to food security, health, education, income stability, and the ability of families to access essential public services. The analysis is informed by the Human Development and Family Studies (HDFS) perspective, in which the household is considered an important unit for understanding the consequences of welfare access.

2.3 To identify major last-mile barriers affecting digital welfare delivery

The third objective is to identify the practical difficulties encountered by users while accessing digital welfare services. Particular attention is given to factors such as biometric authentication failure, unstable internet connectivity, limited access to digital devices, low digital literacy, language-related difficulties, and dependence on intermediaries such as Common Service Centres (CSCs).

These challenges are considered not merely as isolated technical problems but as part of the wider service-delivery environment. A failure at any point in the delivery chain can affect the user's ability to obtain the intended benefit.

2.4 To examine the gap between policy design and actual implementation

The fourth objective is to examine the difference between the expected functioning of digital welfare platforms and their performance under real-world conditions. Digital systems are generally designed for scalability, transparency, speed, and administrative efficiency. However, their effectiveness at the last mile may be influenced by local infrastructure, user capability, institutional support, and socio-economic conditions.

The study therefore attempts to distinguish between system-level capability and effective user-level access.

2.5 To analyse the role of human and infrastructural factors in determining welfare outcomes

The fifth objective is to examine how factors outside the core digital platform influence the final outcome of welfare delivery. These include network availability, device ownership, electricity, digital skills, physical distance to service points, waiting time, and availability of local assistance.

This objective is important because a digitally available service cannot automatically be considered an effectively accessible service. The study therefore examines the complete chain of interaction between the digital system, service-delivery interface, and household.

2.6 To propose an integrated framework for inclusive and resilient digital welfare delivery

The final objective is to develop a practical conceptual framework that can address the identified gaps without

requiring the replacement of existing welfare platforms. The proposed Integrated Rural Digital Support Ecosystem (IRDSE) seeks to connect existing cloud infrastructure with localized digital access hubs, assisted service delivery, edge-level support, and hybrid online-offline mechanisms.

The proposed framework aims to improve accessibility, reduce unnecessary dependence on intermediaries, support service continuity during connectivity disruptions, and make digital welfare delivery more responsive to household-level needs.

Table 1. Objectives and Analytical Focus of the Study

S. No.	Objective	Major Area of Analysis
1	Examine the functioning of cloud-enabled welfare systems	Ground-level operation of PDS, DBT, CoWIN, DIKSHA and eNAM
2	Assess the relationship between digital access and household well-being	Food security, health, education and income stability
3	Identify last-mile barriers	Connectivity, authentication, devices, literacy and intermediary dependence
4	Examine the policy–implementation gap	Difference between intended system performance and actual user experience
5	Analyse human and infrastructural factors	Travel, waiting time, digital skills, infrastructure and local support
6	Propose an integrated welfare-delivery framework	IRDSE, localized access, edge support and hybrid service delivery

Core Analytical Focus: The objectives collectively shift the focus of the study from "whether digital welfare systems are technically capable" to "whether people can effectively access and benefit from these systems under real-world conditions."

This distinction provides the basis for the subsequent case-study analysis of PDS, DBT, CoWIN, DIKSHA, and eNAM.

III. METHODOLOGICAL APPROACH

The present study adopts a qualitative case study approach to examine the functioning of selected digital welfare systems in India from a socio-technical and household-level perspective. The methodology is designed to understand not only how these systems are technically structured, but also how their functioning is influenced by the social, infrastructural, and institutional conditions in which they are accessed. (NITI Aayog, 2022; MeitY, 2023)

The study focuses on five digital welfare and public-service platforms: Aadhaar-enabled Public Distribution System (PDS), Direct Benefit Transfer (DBT), CoWIN, DIKSHA, and eNAM. These platforms represent different areas of public service delivery, including food security, financial assistance, healthcare, education, and agricultural marketing. Their inclusion allows the study to examine whether similar last-mile challenges occur across different sectors.

3.1 Research Design

A qualitative case study design has been adopted because the central concern of the study is the relationship between digital system design and actual user experience. Rather than treating transaction volume or technical capacity as the only indicators of effectiveness, the study examines how digital welfare systems operate when they encounter practical conditions such as limited connectivity, device constraints, varying levels of digital literacy, and dependence on assisted access.

The approach is therefore interpretative and exploratory in nature. It seeks to identify recurring patterns across the selected welfare systems and to understand how technological and non-technological factors jointly influence service delivery.

3.2 Sources of Information

The study primarily draws upon secondary information and publicly available institutional sources. These include government reports, policy documents, official programme information, platform-level statistics, and publicly available information relating to the selected welfare systems.

The source framework considered in the study includes information associated with:

- NITI Aayog;
- Ministry of Electronics and Information Technology;
- Ministry of Health and Family Welfare;
- Ministry of Education;

- Ministry of Agriculture and Farmers Welfare;
- Direct Benefit Transfer Mission; and
- Relevant government platforms and dashboards associated with PDS, DBT, CoWIN, DIKSHA, and eNAM.

The purpose of using these sources is to understand the intended design and operational structure of the systems while examining the practical issues identified in the case-study analysis.

3.3 Selection of Case Studies

The five systems were selected because they represent different dimensions of welfare and public-service delivery.

Platform	Broad Sector	Primary Service Focus
Aadhaar-enabled PDS	Food Security	Distribution of subsidized food grains
DBT	Financial Welfare	Direct transfer of benefits
CoWIN	Healthcare	Digital vaccination registration and certification
DIKSHA	Education	Digital learning resources
eNAM	Agriculture	Digital agricultural market access

This cross-sector selection enables the study to examine whether digital access barriers are specific to a particular welfare programme or represent a broader issue within last-mile digital governance.

3.4 Unit of Analysis

The study considers the household as an important unit of analysis, rather than limiting the assessment to individual users or digital transactions. This approach is particularly relevant from the Human Development and Family Studies (HDFS) perspective because welfare services often have consequences that extend beyond the individual beneficiary.

For instance, access to subsidized food affects household nutrition, access to financial transfers influences household financial stability, access to digital education affects children's learning continuity, and agricultural market access can influence household income opportunities.

The household-level perspective therefore helps connect digital service accessibility with broader human development outcomes.

3.5 Analytical Parameters

The selected case studies are examined through a common set of human-centred and operational parameters. These parameters include:

1. Accessibility – whether users can practically reach and use the service.
2. Time requirement – time required to complete a transaction or obtain a service.
3. Dependence on intermediaries – extent to which users require assistance from CSC operators, banking correspondents, service providers, or other intermediaries.
4. Digital usability – ease or difficulty of navigating the digital interface.
5. Authentication reliability – frequency and nature of biometric or other authentication-related difficulties.
6. Connectivity dependence – extent to which service delivery depends upon continuous internet connectivity.
7. Device availability – whether users have access to suitable smartphones, computers, or other required devices.
8. Digital literacy – ability of users to independently understand and operate the digital service.
9. Household-level impact – effect of accessibility or access barriers on food, health, education, income, and overall family well-being.

These parameters allow the five case studies to be examined using a broadly consistent framework.

3.6 Socio-Technical Perspective

The methodology combines technological and human dimensions of welfare delivery. From the engineering perspective, the study considers cloud infrastructure, centralized databases, authentication mechanisms, digital platforms, connectivity, and local computing requirements. At the same time, the socio-human dimension considers literacy, accessibility, trust, user behaviour, household circumstances, and dependence on intermediaries. This approach is important because a digital welfare system does not operate in isolation. Its actual outcome is produced through interaction between technology, institutions, service providers, infrastructure, and users.

3.7 Ground-Level Analytical Lens

The analysis pays particular attention to the difference between system availability and effective access.

A service may technically be available through a digital platform, but a beneficiary may still face difficulties in obtaining it because of:

- network disruption;
- biometric mismatch;
- lack of a suitable device;
- limited digital skills;
- language or interface difficulties;
- travel to a service point;
- waiting time;
- transaction failure; or
- dependence on another person for completing the process.

These factors are treated as part of the last-mile service-delivery environment rather than as isolated technical incidents.

3.8 Analytical Process

The study follows a sequential analytical process. First, the intended function of each digital welfare system is identified. Second, the practical access conditions and recurring barriers associated with its use are examined. Third, the implications of these barriers for household-level outcomes are considered. Finally, common patterns across the five systems are identified and used to develop the proposed Integrated Rural Digital Support Ecosystem (IRDSE).

This process allows the study to move from individual platform analysis towards an integrated understanding of digital welfare delivery.

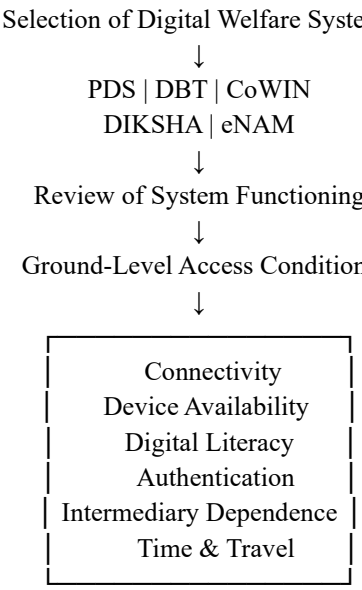

Figure 2. Methodological Framework of the Study

Figure Explanation: The methodological framework illustrates how the study moves from an examination of individual digital welfare platforms towards a broader assessment of their household-level implications. The analysis first considers the intended functioning of each platform and then examines the conditions under which users interact with these systems. The resulting user experience is linked with household-level outcomes, allowing common last-mile barriers to be identified across different sectors. These findings provide the analytical foundation for the proposed IRDSE framework.

Table 2. Analytical Parameters Used in the Case Study

Parameter	Key Question
Accessibility	Can beneficiaries practically access the service?
Time	How much time is required to obtain the service?
Intermediary Dependence	Is assistance from another person required?
Digital Usability	Can users navigate the system easily?
Authentication	Are authentication failures affecting access?
Connectivity	Does service delivery depend on continuous network availability?
Device Access	Do households have suitable digital devices?
Digital Literacy	Can users independently operate the platform?
Household Impact	What are the consequences for family well-being?

Methodological Insight

The methodology therefore places emphasis on how digital welfare systems are experienced in real-world conditions, rather than assessing their effectiveness solely through technical capacity or transaction-level indicators. This provides the basis for examining the

gap between digital system design and actual service delivery at the last mile.

IV. DETAILED CASE STUDY ANALYSIS

This section presents a ground-level analysis of five selected digital welfare and public-service platforms in India: The Aadhaar-enabled Public Distribution System (PDS), Direct Benefit Transfer (DBT), CoWIN, DIKSHA, and eNAM. The purpose of examining these platforms together is to understand how digital systems designed for large-scale public service delivery function when they reach the final point of interaction with citizens.

Each case is examined through four connected dimensions: intended functioning, ground-level access challenges, practical responses, and implications for households. This structure makes it possible to compare the technological objectives of each platform with the conditions under which users actually access the service.

4.1 Aadhaar-Enabled Public Distribution System (PDS)

4.1.1 Intended Functioning

The Aadhaar-enabled Public Distribution System is designed to support the delivery of subsidized food grains to eligible beneficiaries through a digitally supported authentication and distribution process. At the service point, the beneficiary's identity is authenticated and the relevant information is accessed through the digital system before the ration is distributed. The use of digital authentication and centralized information systems is intended to improve transparency in food distribution, strengthen beneficiary identification, and reduce duplication. From an administrative perspective, the system provides a mechanism through which beneficiary information and transactions can be digitally recorded. However, the effectiveness of such a system depends not only on the availability of the digital platform but also on whether authentication and connectivity work reliably at the ration shop.

4.1.2 Ground-Level Challenges

The case study identifies several practical barriers that may affect access to PDS services:

- Fingerprint mismatch, particularly among elderly persons and manual workers;
- Internet connectivity problems during authentication;
- Waiting and queues at ration shops;
- Repeated visits when authentication or system processes fail; and
- Dependence on local service conditions for completing the transaction.

These issues demonstrate that the success of digital authentication depends on the reliability of the complete service-delivery chain.

4.1.3 Practical Measures

The study identifies the following possible measures for improving service continuity:

- Multi-layer authentication combining biometric, OTP, and assisted/manual verification;
- Offline or token-based mechanisms that can support service delivery during temporary system failures; and
- Local data caching or temporary offline verification mechanisms where technically and administratively appropriate.

The purpose of such measures is not to weaken digital authentication but to provide an alternative route when the primary digital mechanism is temporarily unavailable.

4.1.4 Household-Level Implications

Food distribution is directly connected with household nutrition. Consequently, even a temporary difficulty in accessing ration can have consequences beyond the individual beneficiary. In households with limited financial resources, delays in food access may increase vulnerability and place additional pressure on household expenditure. From an HDFS perspective, PDS accessibility therefore needs to be understood not simply as a successful authentication event but in terms of whether the household receives the intended food entitlement in a timely and reliable manner.

Table 3. Aadhaar-Enabled PDS: System Design and Ground-Level Reality

Dimension	Intended System Function	Ground-Level Concern	Possible Response
Authentication	Digital beneficiary verification	Fingerprint mismatch	Alternative authentication

Connectivity	Online transaction processing	Network disruption	Offline/assisted mechanism
Service Access	Timely ration distribution	Queues and repeated visits	Better local service management
User Capability	Direct interaction with system	Limited digital familiarity	Assisted access
Household Outcome	Food security	Delay in receiving ration	Continuity mechanism

Case Insight: The PDS case indicates that a digitally enabled food-distribution system can improve administrative transparency while still facing difficulties at the last mile. The key issue is therefore not simply whether digital authentication exists, but whether beneficiaries can successfully complete the process under actual local conditions.

4.2 Direct Benefit Transfer (DBT)

4.2.1 Intended Functioning

Direct Benefit Transfer is designed to transfer eligible benefits directly into beneficiaries' bank accounts. The central idea is to reduce unnecessary intermediaries and improve transparency in the transfer of public benefits.

From the system perspective, direct transfer can make the payment process more traceable and reduce dependence on physical distribution mechanisms. However, receiving money in a bank account does not necessarily mean that the beneficiary can access those funds easily.

The final stage of the process actually withdrawing or using the transferred amount is particularly important from a household perspective.

4.2.2 Ground-Level Challenges

The study identifies several barriers that can affect effective access to DBT:

- Bank branches may be located at considerable distances from villages;
- Beneficiaries may have to spend time waiting at service points;
- Micro-ATM or biometric authentication may fail;
- Users may not always have clear information about the status of a transaction; and
- Physical travel creates additional time and financial costs.

These issues highlight an important distinction between digital transfer and effective access to transferred funds.

4.2.3 Hidden Cost of Direct Benefit

The case illustrates that a benefit can be digitally transferred while still imposing indirect costs on the beneficiary.

Travel Cost + Waiting Time + Transaction Failure = Hidden Cost of "Direct" Benefit

This does not mean that DBT itself is ineffective. Rather, it shows that the last-mile access mechanism remains an important part of the overall welfare-delivery process.

4.2.4 Practical Measures

The study identifies the following measures:

- Wider availability of Banking Correspondents (BCs);
- Integration of DBT withdrawal services through Common Service Centres;
- Local-language SMS and voice alerts;
- Improved awareness regarding transaction status and service availability.

4.2.5 Household-Level Implications

For rural households, the cost of travelling to a bank or service point can be significant in terms of both money and time. Waiting periods and failed transactions may require additional visits. From an HDFS perspective, these hidden access costs can influence household financial stability, particularly when the transferred amount is intended for essential consumption or immediate household requirements.

Table 4. DBT: Digital Transfer versus Effective Access

Dimension	Digital System Advantage	Ground-Level Barrier	Household Effect
Fund Transfer	Direct account transfer	Difficulty accessing funds	Delayed use of benefit
Banking Access	Digital banking network	Distance from bank	Travel cost
Authentication	Biometric/micro-ATM support	Authentication failure	Repeat visits

Information	Digital transaction record	Limited awareness	Uncertainty
Service Delivery	Reduced intermediaries	Dependence on local access points	Additional effort

Case Insight: The DBT case demonstrates that the concept of "direct" benefit delivery needs to be examined beyond the point of digital transfer. Effective welfare delivery also depends on whether beneficiaries can conveniently and reliably access the transferred funds.

4.3 CoWIN Platform

4.3.1 Intended Functioning

CoWIN was developed as a centralized digital platform for vaccination-related services, including registration, appointment or slot management, and generation of vaccination certificates.

The platform demonstrated the potential of cloud-supported digital systems to coordinate large-scale public health services. However, the ability to independently access such a platform depends on the user's access to a suitable device, internet connectivity, digital literacy, and familiarity with online processes.

4.3.2 Ground-Level Challenges

The case study identifies the following barriers:

- Limited access to smartphones;
- Low levels of digital literacy;
- Language-related difficulties;
- Dependence on CSC operators or other intermediaries.

These factors can shift the user experience from independent digital access to assisted access.

4.3.3 Practical Measures

Possible measures include:

- Assisted registration through CSCs;
- Multilingual interfaces;
- Hybrid arrangements that combine digital booking with appropriate walk-in access.

Such arrangements can help ensure that digitalization does not become the sole condition for receiving an essential public health service.

4.3.4 Human Development Implications

The platform supported organized vaccination management, but users with limited digital access could become dependent on intermediaries to complete basic processes.

From an HDFS perspective, this raises an important issue of digital autonomy. A service may be formally available to everyone while the ability to use it independently remains unequal.

Table 5. CoWIN: Digital Access and User Dependency

Factor	Intended Advantage	Ground-Level Issue	Practical Response
Smartphone access	Self-service registration	No personal device	Assisted access
Digital literacy	Independent use	Difficulty navigating platform	Local assistance
Language	Wider digital reach	Language barrier	Multilingual interface
Booking	Organized vaccination access	Digital-only dependency	Hybrid access
User autonomy	Direct service access	Dependence on intermediaries	Assisted but user-centred design

Case Insight: The CoWIN case illustrates that digital efficiency and digital inclusion are not necessarily the same. A highly capable digital platform can still require assisted access for sections of the population with limited devices, skills, or language familiarity.

4.4 DIKSHA Platform

4.4.1 Intended Functioning

DIKSHA provides digital educational resources for students and teachers and became particularly relevant during periods when conventional classroom-based learning was disrupted.

Digital educational platforms can increase the availability of learning resources and allow students and teachers to access content beyond the physical classroom. However, the effectiveness of digital learning depends strongly on whether learners have reliable access to devices, internet data, and a suitable environment for study.

4.4.2 Ground-Level Challenges

The study identifies three important challenges:

- A single mobile device may be shared among several children;
- Limited internet data may restrict regular access;

- Lack of an appropriate study environment may affect learning.

These barriers show that digital educational access is influenced by household conditions rather than by the platform alone.

4.4.3 Practical Measures

The study proposes:

- Downloadable content that can be accessed offline;
- Low-data or "lite" versions of applications;
- Community-based digital learning centres.

These measures can reduce the dependence of learning continuity on continuous personal-device and high-speed internet access.

4.4.4 Household-Level Implications

When digital learning resources are available but access is unequal, learning continuity can vary across socio-economic groups. Children from households with better devices, connectivity, and study environments may benefit more consistently than those sharing limited resources.

From an HDFS perspective, this demonstrates how household resource conditions can influence the effectiveness of a digital education intervention.

Table 6. DIKSHA: Digital Learning and Household Access

Dimension	Digital Opportunity	Ground-Level Constraint	Possible Response
Device	Digital learning access	Shared mobile	Community access
Internet	Online content	Limited data	Low-data content
Learning continuity	Anytime access	Connectivity limitation	Offline content
Study environment	Home-based learning	Limited space/environment	Community learning centres
Equity	Wider content availability	Unequal household resources	Assisted/local access

Case Insight: The DIKSHA case demonstrates that digital availability does not automatically ensure equal educational opportunity. The household's access to devices, data, and an appropriate learning environment remains an important determinant of actual benefit.

4.5 eNAM (National Agriculture Market)

4.5.1 Intended Functioning

eNAM is designed to provide farmers with access to a unified digital agricultural market and support improved price discovery. The platform seeks to reduce information and market-access barriers and potentially reduce excessive dependence on intermediaries. From an agricultural development perspective, digital market access can provide useful opportunities for farmers who are able to understand, access, and use the system effectively.

4.5.2 Ground-Level Challenges

The case study identifies:

- Limited awareness among some farmers;
- Difficulty in using digital platforms;
- Lack of confidence or trust in online transactions.

These factors may affect the adoption of digital agricultural services, particularly among farmers who have limited exposure to digital tools.

4.5.3 Practical Measures

Possible measures include:

- Digital assistance at mandi/service points;
- Practical training programmes for farmers;
- Incentive-based approaches to encourage adoption.

The objective should be to combine digital market infrastructure with appropriate local-level support rather than assuming that availability of a platform will automatically lead to adoption.

4.5.4 Human Development Implications

The benefits of digital market systems may not be distributed equally among farmers. Farmers who are more familiar with digital platforms may find it easier to use digital market information and services, while marginal or less digitally confident farmers may continue to depend on traditional channels. From an HDFS perspective, this can influence household income opportunities and may contribute to differences in the benefits derived from digital agricultural infrastructure.

Table 7. eNAM: Digital Market Access and Farmer Inclusion

Dimension	Intended Benefit	Ground-Level Challenge	Possible Response

Market information	Better price discovery	Limited awareness	Farmer awareness programmes
Digital access	Direct platform use	Difficulty using digital systems	Local assistance
Transactions	Greater transparency	Trust deficit	Demonstration and support
Adoption	Wider participation	Unequal digital capability	Training
Household impact	Better market opportunity	Unequal participation	Inclusive digital support

Case Insight: The eNAM case indicates that digital agricultural infrastructure can create new opportunities, but the extent to which farmers benefit depends on awareness, digital capability, confidence, and availability of local assistance.

4.6 Cross-Case Comparison: Common Pattern Across Welfare Systems

The five cases differ substantially in their sectors and intended functions. PDS is concerned primarily with food security, DBT with financial transfers, CoWIN with healthcare, DIKSHA with education, and eNAM with agricultural markets. Despite these differences, a common pattern can be observed.

The digital platforms provide the technological foundation for service delivery, but the final outcome is influenced by factors operating outside the core digital system.

Table 8. Cross-Case Comparison of Last-Mile Barriers

Welfare System	Primary Service	Major Access Barrier	Main Human/Household Concern
PDS	Food security	Authentication and connectivity	Nutrition and food security
DBT	Financial transfer	Bank access and transaction failure	Financial stability
CoWIN	Healthcare	Device and digital literacy	Access and user autonomy
DIKSHA	Education	Shared devices and data limitations	Learning continuity
eNAM	Agriculture	Awareness and digital skill gap	Income and market participation

The comparison suggests that the central challenge is not necessarily the technological capability of the welfare platforms. Instead, the major concern lies in the last-mile conditions through which citizens interact with these systems.

This observation provides the basis for the next section, which examines the difference between expected system performance and actual ground-level performance.

4.6 Gap Between System Design and Ground Reality

The case-wise analysis of PDS, DBT, CoWIN, DIKSHA, and eNAM indicates a recurring difference between the way digital welfare systems are designed and the way these systems are experienced at the last mile. At the system level, the selected platforms are intended to improve efficiency, transparency, accessibility, and the scale of public service delivery. However, the actual experience of beneficiaries can be influenced by factors that are not fully visible in backend system performance.

A digital platform may be capable of processing a transaction quickly, but the beneficiary may still experience delay because of network problems, authentication failure, lack of a suitable device, limited digital literacy, physical distance from a service point, or dependence on an intermediary. Consequently, system-level performance and user-level performance should not always be treated as identical.

The difference can be understood through two broad dimensions:

Expected Performance: This represents the intended level of functioning based on the design and objectives of the digital welfare system.

Ground-Level Performance: This represents the practical experience of accessing the service under conditions such as limited connectivity, device constraints, digital literacy gaps, authentication problems, and local infrastructure limitations.

The comparison is therefore not intended to suggest that any particular welfare platform has an officially measured performance score. Rather, it provides a conceptual analytical representation of the gap identified through the case-study framework.

Figure 3. Expected Performance and Ground-Level Performance of Selected Digital Welfare Systems

Welfare System	Expected Performance	Ground-Level Performance
Aadhaar-enabled PDS	Very High	Moderate
DBT	Very High	Moderate
CoWIN	Very High	Moderate
DIKSHA	Very High	Low–Moderate
eNAM	High	Low–Moderate

Note: The performance levels shown in Figure 3 are conceptual analytical assessments developed for the present case study. They are not official government performance scores or independently measured numerical indicators.

Interpretation of the Comparison

The comparison suggests that the difference between expected and ground-level performance is particularly associated with the last-mile delivery environment.

In the case of PDS, the intended digital process depends upon successful authentication and connectivity at the ration shop. Therefore, a technically functional system may still result in delayed access when authentication or connectivity becomes a barrier.

In DBT, the digital transfer itself may be completed successfully, but the beneficiary may face difficulties in accessing the transferred amount because of travel distance, waiting time, authentication problems, or limited access to banking facilities. The digital nature of the transfer therefore does not eliminate all physical and transaction-related costs.

CoWIN illustrates another dimension of the gap. The platform can provide an efficient digital mechanism for registration and certification, but users without smartphones, adequate digital literacy, or familiarity with the interface may require assistance from intermediaries.

In DIKSHA, the availability of digital educational content does not necessarily translate into equal learning access. Shared devices, limited data availability, and household study conditions can influence whether students are able to use digital content regularly.

Similarly, eNAM provides a digital mechanism for agricultural market access, but awareness, digital skills, and confidence in online transactions can influence the extent to which farmers actually benefit from the platform.

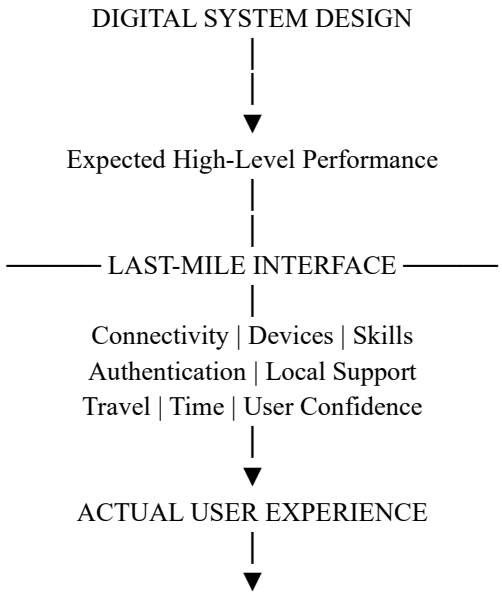

Figure 3: Conceptual Interpretation

The framework demonstrates that the gap does not necessarily originate in the core digital infrastructure. Instead, it may emerge at the interface between the digital system and the conditions in which citizens are expected to access it. This leads to an important distinction between technological efficiency and service accessibility. A system may be technologically efficient but socially difficult to access. Similarly, a platform may be available across a large geographic area while its effective use remains uneven because of local infrastructure and household-level constraints. The findings therefore support the central argument of this study that digital welfare delivery should be assessed through a broader socio-technical lens. The quality of a welfare system cannot be determined only by backend capacity, transaction processing, or platform availability. It must also be examined in terms of whether households can access the intended service reliably, affordably, independently, and within a reasonable time.

Key Analytical Finding

The cross-case analysis indicates that the major concern is better described as an access gap rather than simply a technology gap.

In other words:

Technology provides the capability → Policy provides the mechanism → Infrastructure enables access →

Human factors determine actual use → Household conditions influence the final outcome.

This observation provides the transition to the proposed Integrated Rural Digital Support Ecosystem (IRDSE), which seeks to strengthen the connection between existing digital welfare infrastructure and the households that depend upon it.

V. INTEGRATED OBSERVATION

The analysis of Aadhaar-enabled PDS, DBT, CoWIN, DIKSHA, and eNAM reveals a common pattern in the functioning of digital welfare systems. Although the five platforms operate in different sectors, their effectiveness is influenced by several similar conditions at the last mile. The common issue is not the absence of digital infrastructure, but the difficulty of ensuring that the available technology remains accessible and usable under diverse social and infrastructural conditions.

At the system level, digital technologies provide important advantages. They enable centralized information management, support large-scale service delivery, reduce dependence on paper-based processes, and improve the ability of institutions to monitor transactions and beneficiaries. However, these advantages do not automatically ensure that every beneficiary can access the intended service without difficulty.

The analysis indicates that the actual outcome of a digital welfare intervention is influenced by three broad layers: technological capability, service-delivery conditions, and household-level circumstances.

5.1 Technology Improves Administrative Efficiency

The selected platforms demonstrate the potential of digital technologies to improve the organization and administration of welfare services. Cloud-supported platforms and digital databases can support large-scale information processing and facilitate more standardized service delivery. However, technological capability primarily establishes what a system can do. It does not by itself determine whether a beneficiary can use the service successfully.

5.2 Policy Provides the Delivery Mechanism

Digital welfare systems operate within policy frameworks that define eligibility, benefits, procedures, and institutional responsibilities. Policy design therefore provides the structure through which technology is translated into a public service.

However, implementation conditions can vary across locations. The same digital mechanism may be experienced differently depending on connectivity, availability of service points, local support, and user capabilities.

5.3 Last-Mile Conditions Determine Effective Access

The case studies indicate that the last-mile interface is one of the most important determinants of actual service access.

Common barriers include:

- unstable or inadequate connectivity;
- biometric or authentication failure;
- limited availability of suitable digital devices;
- varying levels of digital literacy;
- dependence on intermediaries;
- language and interface difficulties;
- travel requirements;
- waiting time; and
- lack of local technical or human assistance.

These factors can transform a technically available service into a difficult or delayed service for the end user.

5.4 Human Factors Influence Actual Outcomes

Digital welfare systems ultimately operate through people. Beneficiaries need to understand the process, access the required device or service point, complete authentication or registration, and respond appropriately when a transaction does not proceed as expected.

Therefore, user confidence, digital familiarity, awareness, and the availability of assistance are important components of effective digital governance.

5.5 Household Conditions Shape the Final Impact

The consequences of digital access barriers extend beyond the individual transaction. Welfare services influence household-level outcomes.

A difficulty in accessing PDS may affect food security. A delay in accessing DBT may affect the household's ability to meet immediate financial requirements. Limited access to DIKSHA may affect children's learning continuity. Difficulties in accessing eNAM

may influence agricultural market participation and household income opportunities.

The HDFS perspective is therefore important because it connects the functioning of digital welfare systems with the broader conditions of family well-being.

Table 9. Integrated Observation Across Selected Digital Welfare Systems

Analytical Layer	Observation	Effect on Service Delivery
Technology	Digital platforms provide scalable service infrastructure	Improves administrative capability
Policy	Welfare programmes establish the delivery mechanism	Provides institutional structure
Connectivity	Network availability varies at the last mile	Can interrupt digital transactions
Authentication	Biometric and digital verification may fail	Can delay or prevent access
Devices	Smartphones and digital devices are not uniformly available	Limits independent access
Digital Literacy	Users have different levels of digital familiarity	Creates unequal usability
Intermediaries	Users may depend on CSCs, BCs, or other assistance	Reduces independent access
Time and Travel	Physical movement may still be required	Creates hidden access costs
Household Conditions	Resources and circumstances differ across families	Influence actual benefit
Human Development	Welfare access affects food, health, education and income	Determines broader household outcomes

5.6 The Central Finding: Access Failure Rather Than Technology Failure

Taken together, the five case studies suggest that the central challenge is better understood as an access problem rather than simply a technology problem.

This does not imply that digital systems are technically unsuccessful. Rather, it highlights the fact that technical capability and effective accessibility are two different dimensions of digital welfare performance.

A simplified representation of the relationship can be expressed as:

Technology Capability + Policy Mechanism + Infrastructure + Human Support = Effective Welfare Delivery

If any of these components is weak, the final outcome may be affected even when the underlying digital platform is technically capable.

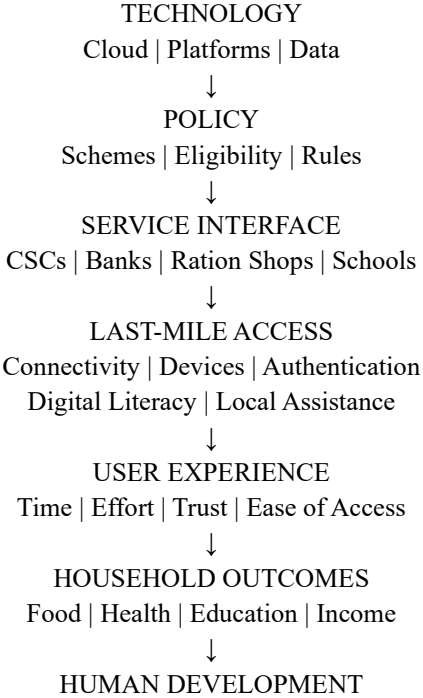

Figure 4. From Digital Capability to Household Outcome

Figure Explanation: The figure presents the central argument emerging from the case studies. Digital technology and policy mechanisms establish the foundation for welfare delivery, but the final outcome is shaped by the service interface and the conditions under which users access the system. Last-mile barriers influence user experience and, consequently, the household-level benefits derived from digital welfare programmes.

5.7 Implication for Digital Welfare Design

The integrated observation indicates that future improvements should not focus exclusively on creating new digital platforms. Greater attention is

required to strengthen the connection between existing platforms and the communities that use them.
This requires a shift from a purely technology-centred model towards a human-centred and household-sensitive model of digital welfare delivery.

The objective should be to ensure that beneficiaries are able to access welfare services:

- with minimum unnecessary travel;
- with reasonable waiting time;
- despite temporary connectivity disruptions;
- through alternative authentication mechanisms where appropriate;
- with local assistance when required; and
- without excessive dependence on intermediaries.

This observation provides the conceptual basis for the Integrated Rural Digital Support Ecosystem (IRDSE) proposed in the next section. The purpose of IRDSE is therefore not to replace existing digital welfare platforms, but to strengthen the access layer connecting these platforms with rural households.

VI. PROPOSED INTEGRATED RURAL DIGITAL SUPPORT ECOSYSTEM (IRDSE)

6.1 Rationale for an Integrated Approach

The analysis of the selected digital welfare systems indicates that the major challenge is not the absence of digital infrastructure. India has already developed a wide range of digital platforms for food distribution, financial transfers, healthcare, education, and agricultural services. The more important concern is the manner in which these systems connect with beneficiaries at the last mile.
At present, different welfare services often require users to interact with different platforms, service points, authentication mechanisms, and intermediaries. A rural household may therefore need to visit a ration shop for food entitlements, a bank or banking correspondent for financial services, a Common Service Centre for digital assistance, a school or community facility for educational access, and a mandi or related service point for agricultural information.
From the perspective of the individual platforms, these arrangements may appear functional. However, from the perspective of a household, the experience can become fragmented.
The fragmentation may result in:

- multiple access points for different welfare services;
- repeated authentication and verification;
- dependence on different intermediaries;
- repeated travel to service locations;
- additional waiting time;
- difficulty during network or server interruptions; and
- increased effort for households with limited digital skills.

The problem can therefore be understood as an access-layer fragmentation between technically capable digital systems and the households that depend on them.
The proposed Integrated Rural Digital Support Ecosystem (IRDSE) is designed to address this gap by creating an intermediate support layer between households and existing digital welfare platforms.
The framework does not propose replacing PDS, DBT, CoWIN, DIKSHA, or eNAM. Instead, it seeks to make their access more coordinated, localized, resilient, and user-friendly.

6.2 Conceptual Basis of IRDSE

The IRDSE framework is based on three interconnected principles:

1. Integration

The first principle is integration. Instead of requiring households to understand and navigate several independent digital systems, a common access mechanism can help users reach multiple welfare services through a coordinated interface.
Integration can reduce:

- repeated processes;
- unnecessary movement between service points;
- duplication of information;
- confusion regarding service procedures; and
- dependence on multiple intermediaries.

The objective is not necessarily to merge the backend databases of all welfare programmes, but to improve the front-end access experience for citizens.

2. Localization

The second principle is localization. Digital welfare services should be adapted to the conditions in which they are actually used.

For rural and semi-urban communities, this may include:

- Panchayat-level digital access;
- Common Service Centres;
- local-language interfaces;
- assisted digital services;
- locally available digital facilitators; and
- support for households with limited devices or digital skills.

Localization brings the service closer to the user instead of expecting every user to independently adapt to the technology.

3. Resilience

The third principle is resilience. Welfare services should continue to function, wherever technically and administratively feasible, even when continuous connectivity is temporarily unavailable.

This may involve:

- temporary local data storage;
- offline transaction support;
- cached information;
- offline tokens;
- delayed synchronization; and
- alternative authentication or assisted verification mechanisms.

The purpose of resilience is particularly important for essential welfare services where a temporary technical disruption should not automatically result in complete denial or indefinite delay of access.

Table 10. Core Principles of the IRDSE Framework

Principle	Existing Concern	IRDSE Approach	Intended Benefit
Integration	Multiple platforms and access points	Coordinated access mechanism	Simpler service access
Localization	Rural users face local infrastructure constraints	Panchayat/CSC-level support	Better last-mile accessibility
Resilience	Dependence on continuous connectivity	Hybrid online-offline support	Greater service continuity
Human-centred Design	Unequal digital capability	Assisted and simplified access	Greater inclusion
Household Orientation	Services are often accessed separately	Household-level welfare perspective	Better family-level outcomes

6.3 IRDSE Architecture

The proposed IRDSE architecture introduces a localized access and support layer between the household and centralized digital infrastructure.

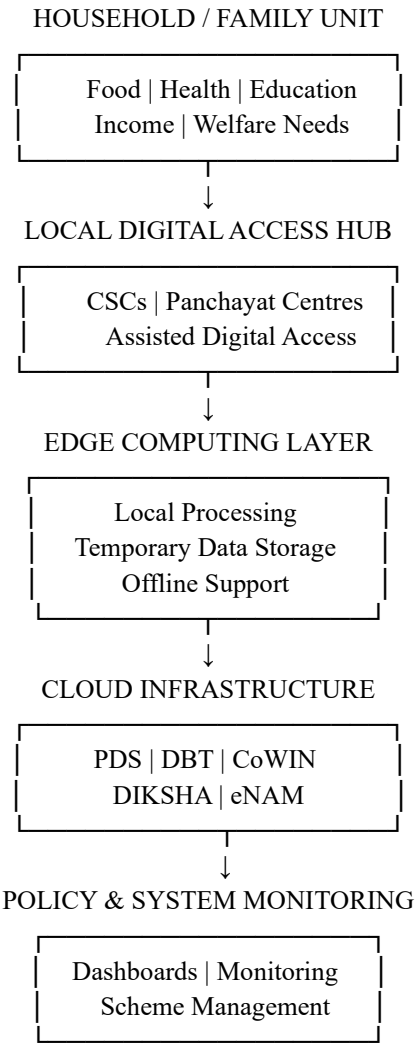

Figure 5. Integrated Rural Digital Support Ecosystem (IRDSE) Architecture

Figure Explanation: The proposed architecture places the household at the centre of the service-delivery model. A Local Digital Access Hub acts as the primary interface between the household and centralized digital platforms. An edge computing layer provides localized processing and temporary support during connectivity limitations, while the existing cloud

infrastructure continues to provide the main digital service environment. Policy and monitoring mechanisms remain connected to the system to support administrative oversight.

The architecture is therefore designed as a support and access ecosystem, rather than as a replacement for existing government digital platforms. The original study similarly proposes an intermediate layer between households and centralized cloud systems to simplify access and reduce dependence on continuous connectivity.

6.4 Key Components of the IRDSE Model

6.4.1 Household-Centric Service Design

The first component of IRDSE is the household-centric approach.

Existing welfare systems are generally organized around individual beneficiaries, specific schemes, or individual transactions. However, from an HDFS perspective, the consequences of welfare access extend across the household.

IRDSE therefore treats the household as an important point of reference for understanding combined welfare requirements.

For example, a household may simultaneously require:

- food support;
- financial assistance;
- health-related services;
- educational resources; and
- agricultural or livelihood-related information.

A household-centric approach does not mean that all schemes must have identical eligibility rules. Instead, it means that the access mechanism should recognize that families interact with several welfare services as part of their everyday lives.

Expected contribution:

- reduced duplication of access processes;
- better understanding of combined household needs;
- simplified service navigation;
- improved continuity of essential services; and
- stronger connection between digital service access and household well-being.

6.4.2 Local Digital Access Hubs

The second component is the establishment or strengthening of Local Digital Access Hubs.

Existing CSCs and Panchayat-level digital centres can potentially serve as important access points within this framework. Rather than creating an entirely separate infrastructure, the approach can build upon existing local service-delivery arrangements.

The hub may provide assistance for:

- PDS-related digital processes;
- DBT-related access;
- CoWIN or other health-related digital services;
- DIKSHA access;
- eNAM-related assistance; and
- other eligible digital public services.

The purpose is to create a recognizable local point where beneficiaries can obtain assistance without having to understand the technical structure of each individual platform.

Potential benefits include:

- reduced travel;
- easier access to multiple services;
- local-language support;
- assistance for users with limited digital literacy; and
- reduced dependence on multiple service providers.

6.4.3 Edge Computing Layer

The edge computing layer represents the primary technical innovation proposed within the framework.

In a conventional cloud-dependent model, many processes require continuous communication between the local user interface and a centralized server. When network connectivity is unstable, the user may experience delays or transaction failure.

The proposed edge layer seeks to move selected processing or temporary data-support functions closer to the point of service.

Potential functions include:

- local data caching;
- temporary storage of permitted information;
- local processing;
- faster response for selected operations;
- offline or near-offline support; and
- synchronization with the central cloud once connectivity is restored.

This approach is intended to reduce the impact of network instability and latency.

However, any implementation involving beneficiary data would need appropriate authentication, authorization, privacy, security, audit, and data-governance controls. The proposed model is therefore conceptual and would require detailed technical and institutional validation before actual deployment.

6.4.4 Hybrid Online–Offline System

The fourth component is a hybrid service-delivery mechanism.

The objective is to avoid making continuous internet connectivity an absolute requirement for every stage of a welfare interaction, particularly where temporary connectivity interruptions are common.

Possible mechanisms include:

- offline tokens for selected PDS processes;
- locally cached information for permitted verification purposes;
- temporary transaction records;
- assisted authentication;
- synchronization after restoration of connectivity; and
- clearly defined fallback procedures.

The system should distinguish between temporary technical unavailability and eligibility or entitlement issues. Offline mechanisms should not bypass programme rules; they should only provide continuity for authorized transactions where appropriate.

This distinction is important for maintaining both service continuity and administrative accountability.

6.5 How IRDSE Addresses Existing Problems

The following matrix maps the major problems identified in the five case studies to the corresponding IRDSE response.

Table 11. Existing Problems and Proposed IRDSE Responses

Welfare System	Existing Ground-Level Concern	IRDSE Response	Expected Improvement
PDS	Biometric/authentication difficulty	Assisted and alternative access mechanism	Greater continuity
PDS	Network disruption	Local/edge support where feasible	Reduced interruption
DBT	Distance to banking access point	Localized assisted access	Reduced travel burden
DBT	Limited transaction awareness	Local assistance and alerts	Better user understanding
CoWIN	Limited digital literacy	Assisted registration/access	Improved usability
CoWIN	Device limitations	Shared/local digital access	Wider access
DIKSHA	Shared mobile devices	Community/ local digital access	Better learning continuity
DIKSHA	Limited data	Offline/low-data content support	Reduced connectivity dependence
eNAM	Limited digital skills	Local digital facilitation	Improved participation
eNAM	Trust/awareness concerns	Demonstration and assisted use	Greater confidence

The purpose of this matrix is to demonstrate that the proposed framework directly responds to the problems identified during the case-study analysis rather than introducing a completely unrelated technological intervention. The original case study similarly maps PDS, DBT, CoWIN, DIKSHA, and eNAM problems to offline authentication, local withdrawal, assisted registration, shared access, and on-site digital assistance respectively.

6.6 Implementation Strategy

The proposed IRDSE can be considered as a phased framework rather than a single large-scale technological deployment. A gradual approach would allow existing infrastructure and institutional arrangements to be strengthened before introducing additional technical components.

Phase 1: Strengthening Existing Local Infrastructure

The first phase should focus on improving the capacity of existing CSCs and local digital service points.

Key activities may include:

- improving connectivity;
- ensuring basic digital equipment;
- providing reliable power backup where necessary;
- identifying trained digital facilitators; and
- creating a common service-support mechanism.

Phase 2: Deployment of Local/Edge Support
The second phase would introduce selected edge-level capabilities at appropriate block or district levels.
Possible functions include:

- local processing;
- permitted temporary data caching;
- service continuity mechanisms;
- synchronization with centralized systems; and
- technical monitoring.

This phase would require careful attention to cybersecurity, privacy, data governance, and authentication controls.

Phase 3: Integration of Access Mechanisms
The third phase would focus on creating a more coordinated user-facing access mechanism for selected welfare services.
The objective would be to simplify the user journey without necessarily merging the backend architecture of individual schemes.

Phase 4: Capacity Building
The fourth phase would focus on people.
Digital facilitators, CSC operators, Panchayat-level personnel, and other relevant service providers could receive structured training on:

- digital service navigation;
- beneficiary assistance;
- basic troubleshooting;
- privacy and responsible data handling;
- grievance escalation; and
- communication with users in locally appropriate languages.

Phase 5: Monitoring and Feedback
A final and continuing phase would involve monitoring actual service experience.
Indicators could include:

- number of assisted transactions;
- average time required for service access;
- frequency of failed transactions;
- repeated visits;
- connectivity-related interruptions;
- user complaints;
- grievance resolution time; and
- user satisfaction.

These indicators would help shift evaluation from purely backend transaction counts towards a more complete understanding of service accessibility.

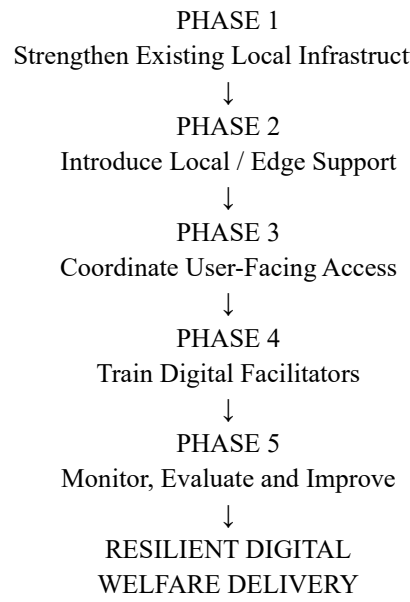

Figure 6. Proposed IRDSE Implementation Roadmap

The phased approach is consistent with the implementation direction already identified in the study: strengthening existing infrastructure, deploying edge systems, integrating access mechanisms, and building local capacity.

6.7 Expected Outcomes
The proposed framework is expected to improve the relationship between digital welfare infrastructure and actual service accessibility.

At the user level, the framework may contribute to:

- easier navigation of welfare services;
- reduced dependence on multiple access points;
- greater availability of local assistance;
- reduced effects of temporary connectivity problems; and
- improved confidence in digital service use.

At the household level, the expected contribution includes:

- more reliable access to food-related services;
- improved access to financial benefits;
- greater continuity of digital educational resources;

- improved access to selected digital health services; and
- better access to agricultural market information.

At the administrative level, the framework may support:

- better monitoring of last-mile problems;
- identification of recurring service failures;
- improved feedback from local users;
- more systematic grievance identification; and
- better alignment between digital system design and actual user conditions.

Table 12. Expected Outcomes of the IRDSE Framework

Level	Expected Outcome
Individual	Easier and more assisted access to digital services
Household	Reduced time, effort and access barriers
Community	Stronger local digital support infrastructure
Service Delivery	Better continuity during temporary disruptions
Administration	Improved visibility of last-mile problems
Human Development	More reliable access to food, health, education and income-related services

6.8 Overall Contribution of IRDSE

The proposed IRDSE framework does not argue that India requires a completely new set of welfare platforms. The central proposition is that existing digital welfare systems require a stronger and more responsive last-mile support layer.

The framework therefore attempts to connect five elements:

Existing Digital Infrastructure + Local Access + Edge Support + Human Assistance + Household-Centred Design

The combination of these elements can potentially improve the practical accessibility of welfare services while preserving the advantages of centralized digital systems.

The proposal is conceptual and should be understood as a framework for further technical, administrative, and field-level validation. Its actual implementation would require assessment of interoperability, data protection, cybersecurity, institutional responsibilities, infrastructure costs, and programme-specific legal and operational requirements.

The broader contribution of IRDSE lies in shifting the discussion from digital availability to effective digital accessibility. In this approach, the success of a welfare platform is not determined only by whether the technology works at the backend, but also by whether a household can successfully obtain the intended service when it needs it.

VII. CONCLUSION

The digital transformation of public welfare delivery has created significant opportunities for improving the scale, transparency, and administrative efficiency of public services in India. Platforms such as Aadhaar-enabled PDS, DBT, CoWIN, DIKSHA, and eNAM demonstrate how digital technologies can be applied across food security, financial welfare, healthcare, education, and agricultural markets.

However, the analysis presented in this study shows that the effectiveness of digital welfare delivery cannot be assessed only on the basis of technological capability or platform availability. The actual benefit received by a household depends on the complete chain connecting digital infrastructure with the final user.

The case studies indicate that several last-mile factors can influence this process. Connectivity problems, authentication difficulties, limited access to suitable devices, digital literacy gaps, dependence on intermediaries, travel requirements, waiting time, and local infrastructure can affect the ability of beneficiaries to use digital welfare services effectively.

The study therefore identifies a distinction between digital availability and effective accessibility. A service may be available through a technically capable digital platform, but its practical value depends on whether users can access it reliably, conveniently, and with reasonable assistance when required.

This distinction is particularly important from the perspective of Human Development and Family Studies. Welfare services are not merely individual digital transactions. Their accessibility can influence household food security, financial stability, health access, educational continuity, and livelihood opportunities. Consequently, the performance of a digital welfare system should also be considered in relation to its implications for household well-being.

The study further demonstrates that the challenges identified across PDS, DBT, CoWIN, DIKSHA, and eNAM are not identical, but they share a common structural characteristic: the gap between centralized digital capability and local conditions of access. This suggests that improving digital welfare delivery does not necessarily require the creation of entirely new platforms. Greater attention is required to strengthen the last-mile interface through which existing systems are accessed.

In response to this concern, the study proposes the Integrated Rural Digital Support Ecosystem (IRDSE). The proposed framework combines existing digital infrastructure with localized access hubs, assisted digital services, edge-level support, hybrid online-offline mechanisms, and household-sensitive service design.

The framework is based on three central principles:

Integration seeks to simplify access to multiple welfare services.

Localization seeks to bring digital support closer to households through local institutions and service points.

Resilience seeks to reduce the effect of temporary connectivity and infrastructure disruptions on essential service delivery.

The proposed framework is not intended to replace existing government digital platforms. Instead, it is designed as an additional support layer connecting these platforms with the communities that depend upon them.

Table 13. Major Findings and Proposed Direction

Study Finding	Implication	Proposed Direction
Digital platforms improve administrative capability	Technology can support large-scale welfare delivery	Continue strengthening digital infrastructure
Last-mile connectivity remains important	Technical availability may not ensure access	Local and resilient connectivity support
Authentication can create access difficulties	Some users may experience transaction failure	Appropriate alternative/assisted mechanisms
Device and digital literacy gaps persist	Independent access is unequal	Assisted and inclusive digital access
Multiple service points increase user effort	Households may face fragmented access	Coordinated local access
Household conditions influence welfare outcomes	Individual digital access has wider family implications	Household-sensitive service design
Existing platforms are valuable but fragmented at the access layer	Replacement is not necessarily required	Strengthen the last-mile support ecosystem
Digital welfare needs continuity	Temporary technical disruption can affect access	Hybrid online-offline and resilience mechanisms

7.1 Final Perspective

The central argument of this study can be summarized as follows:

Digital welfare succeeds not merely when the platform works, but when the household can successfully use the service.

This requires a shift from measuring digital governance primarily through system capability towards evaluating effective, inclusive, and resilient access.

The future of digital welfare delivery therefore lies not only in more powerful cloud systems, larger databases, or greater automation. It also lies in designing systems that recognize the realities of users—their connectivity, devices, digital skills, physical access, household circumstances, and need for human assistance.

The IRDSE framework provides a conceptual direction for this shift. Its practical value would require further field-level research, technical validation, cost assessment, institutional examination, and evaluation under different rural and semi-urban conditions. Nevertheless, the framework establishes a useful basis for thinking about digital welfare as a socio-technical ecosystem rather than merely a collection of digital platforms.

Ultimately, inclusive digital governance should ensure that technological progress translates into meaningful improvements in people's everyday lives. The measure of success is therefore not simply the efficiency of the digital system, but the reliability, accessibility, dignity, and usefulness of the service delivered to the household.

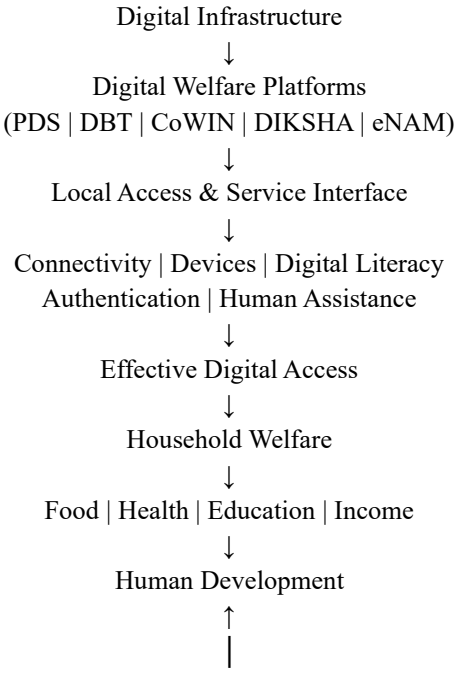

Figure 7. Overall Conceptual Pathway of the Study

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