

## Research Article

# Designing for Food Security: Portability and the Expansion of User Freedoms Through the COREPDS in Chhattisgarh, India

Prashant Rajan  
Shweta Chopra

Iowa State University, USA

A. K. Somasekhar

National Informatics Centre, India

Chad Laux

Purdue University, USA

## Abstract

*Food insecurity is a complex global problem, with approximately one in eight humans struggling with insufficient access to adequate nutrition. India accounts for the largest share of the world's food-insecure population despite more than four decades of subsidized food production, distribution, and consumption. We report on the public distribution of food through the COREPDS (centralized online real-time public distribution system), an ICT intervention in the public distribution system of Chhattisgarh, India. COREPDS is a theoretically driven ICT intervention that empowers households in Chhattisgarh by offering them the freedom to choose when, where, and how they wish to exercise their constitutionally guaranteed right to food access. We analyze the motivations to use ICTs to democratize food access and measure the extent to which geographic location and socioeconomic status affect utilization of user freedoms. Our analysis has significant implications for framing national ICT policies in ways that emphasize frugal, flexible, local alternatives to mega e-infrastructure.*

## 1. Food Insecurity: A Complex Social Problem

Food security is a universal human right, involving consistent access to quantitatively and qualitatively adequate nutritional sources. Written into declarations of the right to food is the tenet that such access must be achieved in socially acceptable ways, ensuring that human health and well-being are achieved with dignity (Ziegler, 2002). Information and communication technologies (ICTs) have emerged as key tools to implement food security policies. Yet research on food policy interventions has under-examined the role of technology in affording and constraining food access. Despite the potential for ICTs “to amplify” rather than substitute for “intents and capacities” of individuals and institutions (Toyama, 2011), contemporary food policy research either conceptualizes technology in quotidian terms as a logistical component of policy implementations or it valorizes ICTs as deterministic harbingers of transparency and efficiency. Policy changes and their implementation are evaluated through macrolevel measurements of the proportion of food that is lost and “leaked” through agricultural value chains (Gulati & Saini, 2015; Khera, 2011a). Missing from this picture is an

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To cite this article: Rajan, P., Chopra, S., Somasekhar, A. K., & Laux, C. (2016). Designing for food security: Portability and the expansion of user freedoms through the COREPDS in Chhattisgarh, India. *Information Technologies & International Development*, 12(3), 1–18.

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Table 1. List of Abbreviations.

APL	Above poverty line
BPL	Below poverty line
COREPDS	Centralized online real-time electronic public distribution system
FPS	Fair price shop
GPRS	General packet radio service
NIC	National Informatics Centre
PDS	Public distribution system
RSBY	<i>Rashtriya Swastha Beema Yojana</i> , or National Health Insurance Program
UID	Unique identification

explanation for how households experience the ICT-mediated process of obtaining food access (cf. Khera, 2014).

In the ICTD (ICTs for development) literature, studies of relevance to the topic of food security include designs and implementations of ICT-based platforms that address informational asymmetries in agricultural markets and measures of household access to ICT infrastructures in rural areas (Wang & Chen, 2012). The ICTD literature contains several successful (Abraham, 2007) and unsuccessful (Srinivasan & Burrell, 2013) cases of ICT adoption and use by food producers. Lacking in this literature is an account of variation in ICT use by food consumers (cf. Barnett & Gallegos, 2013) in direct consequence of government food policies.

Of common interest to both ICTD and food policy researchers are large-scale e-infrastructures such as the *Aadhaar*/Unique Identification (UID) project, billed as the world's largest biometric database. The rationale, implementation, and utility of such "mega e-infrastructures" (Srinivasan & Johri, 2013) have been debated and critiqued by development economists (Khera, 2014) and ICTD scholars (Srinivasan & Johri, 2013), alike. A key recommendation across these literatures has been a call for greater sensitivity to the contexts in which citizens make use of policy-driven public infrastructures.

In the following sections, we first juxtapose the debate on *Aadhaar*<sup>1</sup> across these two parallel literatures against India's policy imperative to ensure adequate and dignified food access for more than 600 million Indian citizens. Second, we examine how regional and national ICT policies have diverged in their efforts to improve the efficacy of India's primary food security program, its public distribution system (PDS). Specifically, we narrate the sequence of administrative and technological interventions that have accompanied improvements in PDS access in Chhattisgarh, a state that exemplifies a "new-style PDS" (Drèze & Sen, 2013, p. 206), which has addressed legacy issues related to graft and diversion of food. Third, we describe Chhattisgarh's centralized online real-time electronic public distribution system (COREPDS), the current iteration of an eight-year-long process of improving PDS access through ICT-based interventions. Using a combination of participant observation, interviews, archival research, and quantitative analysis of transactions generated in the COREPDS database, we explain how use of ICT-enabled food access in Chhattisgarh is influenced by geographic location and socioeconomic status. Our results indicate that the expansion of user freedom to access food may not occur in direct proportion to the scale, cost, or complexity of technology. Locally relevant ICT-based interventions may better nurture citizens' freedoms as ICT users to choose where, when, and how they wish to purchase food.

## 2. Food Security in India: The Challenge of Ensuring Food Access

India's PDS is its largest program of economic support to citizens (Drèze & Sen, 2013). An estimated 160 million households are entitled to purchase monthly essential commodities, including wheat, rice, cooking fuel, sugar, and salt, at subsidized costs from a nationwide network of more than 400,000 fair price shops (FPSs).

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1. *Aadhaar in Hindi means foundation or support.*

The PDS has served two key long-term policy objectives that link food producers with consumers: (1) to ensure the equitable and consistent distribution of affordable nutrition and (2) to support farmers by guaranteeing a minimum price for their harvests.

Food distribution via the PDS has been plagued by inefficiencies. In 2010 an estimated 41% of food grains circulating in the PDS supply chain did not reach intended beneficiaries, even as expenditures on food subsidies tripled from 2006–2010 to US\$12.1 billion (Drèze & Khera, 2010; Krishnamurthy, Pathania, & Tandon, 2014). High transaction costs associated with making subsidized food available in government shops, warehouses, and lots rather than accessible to citizens have made it profitable for food to be “leaked” from PDSs into the open market (Drèze & Sen, 2013; Khera, 2011a).

Despite inefficiencies in PDS performance at the national level, several states have demonstrated remarkable recent improvements. Scholars (Drèze & Khera, 2015; Himanshu & Sen, 2013) have documented the positive impact of state-level reforms on PDS access, arguing that persisting inefficiencies in food distribution arise primarily from food allocated to the above-poverty-line (APL) quota that goes unclaimed and is easily diverted to the black market. In their view, such inefficiencies may be ameliorated through universalization of food access, end-to-end computerization of the PDS supply chain, and increased social auditing and administrative vigilance (Himanshu & Sen, 2013). Others (e.g., Krishnamurthy et al., 2014) have studied the political economy of state-level reforms in relation to grain consumption, suggesting that improved PDS access is a regional phenomenon that depends on sustained support from successive political regimes for administrative interventions at the state level, while being influenced by broader national and international trends in grain prices.

The advent of a market-friendly government following general elections in 2014 has intensified the debate over the government’s role in enabling food access, with calls being made both for (Gulati & Saini, 2015) and against (Drèze & Khera, 2015) replacement of the PDS by a system of monthly cash transfers to citizens. The case for shifting to cash transfers hinges on claims that large-scale national ICT projects will eventually link each citizen’s verifiable biometric identity to their bank accounts using their Unique Identification (UID) or Aadhaar<sup>2</sup> number (Gulati & Saini, 2015). Gulati and Saini (2015) estimated that more than 30,000 crore rupees (approx. US\$4.7 billion) could be saved annually if the government transferred cash instead of commodities through such a bankable population of citizens. Such pro-cash transfer claims have met with critiques challenging the legal, privacy, economic, nutritional, and social implications of national ICT policies that seek to make citizens simultaneously invisible to and readable by the state (Johri & Srinivasan, 2014; Srinivasan & Johri, 2013). From a food policy perspective, Aadhaar’s utility is higher as a tool for dismantling the PDS and replacing in-kind transfers to households with cash transfers to individuals, thus signaling the withdrawal of the government from food procurement and distribution (Khera, 2011a). Khera (2014) and Khera and Drèze (2015) have provided empirical evidence to support their claim that citizens prefer in-kind food access to cash transfers and that this preference is stronger in areas where PDS performance is good. The authors clarify the need to examine contextual factors, including whether and how markets function and how individual and household attributes such as socioeconomic status, education level, and social norms influence preferences for in-kind or cash transfers (Khera, 2014).

Despite its stated goals of enabling greater transparency and efficiency in government operations, Aadhaar has received considerable criticism for its potential to compromise the confidentiality of citizens’ information, mandating enrollment for access to government services and creating an “infrastructure of authoritarianism” (Drèze, 2010). An issue receiving less focus is the logistical need for Aadhaar to integrate horizontally across multiple public service verticals such as provision of essential commodities, employment guarantee schemes, nutrition and health care programs before it can function as a foundation (or *aadhaar*) that serves citizens. The purported advantages of distributing benefits to citizens through Aadhaar may only be realized once citizen identities are enumerated, recorded, and collated across multiple service providers’ databases. Aadhaar’s objectives place it at risk of duplicating ongoing and completed regional efforts to digitize demographic data. Further, Aadhaar’s focus on documenting individuals means that its scalability may be lower than that of

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2. Unique identification number and Aadhaar number are synonymous and used interchangeably here.

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regional projects that build on past efforts at integration in a single service vertical. The focus on individuals may limit Aadhaar's utility as a technology for public services catering to households.

Khera (2014) also cautions against the higher transition and transaction costs likely to be imposed on citizens when moving from in-kind transfers to cash transfers. Building on this concept, we suggest that transition and transaction costs may be similarly high when moving citizens from existing regional and local ICT platforms to national mega e-infrastructure. Common to both arguments for and critiques of Aadhaar-based benefits transfer (see Drèze & Sen, 2013) is the notion that political will combined with administrative acumen and technology can enable food access insofar as it is treated as a logistical problem in need of a deterministic solution. We question whether this is indeed the case and ask what using technology for seeking food access means to households rather than to the state.

### 3. Data Collection

Data reported here were collected between June–December 2013 as part of a larger two-year project investigating the co-evolution of technological and administrative innovations in Chhattisgarh's PDS. A combination of criterion-based<sup>3</sup> sampling and a snowball sampling approach was employed to locate key informants responsible for implementing COREPDS. A key criterion for identifying informants was that the individuals be closely involved in designing, implementing, or using the technology underlying COREPDS.

#### 3.1 Guided Conversations

Guided conversations were carried out with five engineers and three bureaucrats who were involved in the design and implementation of ICT-enabled government-mandated initiatives such as the *Mukhya Mantri Khadya Sahayata Yojana* (Chief Minister's Food Relief Scheme). Conversations with these eight individuals yielded information on key criteria for COREPDS: measuring the quality of service delivery and the shop performance level. Of the three civil service officers, two were senior Indian Administrative Service (IAS) cadre with extensive experience and executive responsibility for state-level food distribution. Another civil service member was a senior scientific officer with the National Informatics Centre (NIC), Chhattisgarh. Through these interactions we identified and contacted five engineers, including two senior software developers responsible for designing and maintaining the COREPDS database and three assistant programmers who provided field technical support across three districts (Raipur, Durg, and Mahasamund) for the NIC in Chhattisgarh. The senior software developers shared information on the database organization and identified three field engineers who helped troubleshoot everyday problems at the shop level. The field engineers provided leads on high- and low-performing shops.

#### 3.2 Participant Observation at FPSs

Participant observation of entitlement purchases and interactions with shop employees were carried out across 36 fair price shops (FPSs) in urban, semi-urban, and rural regions of Chhattisgarh's Raipur (15 shops), Durg (two shops), and Mahasamund (19 shops) districts. Observation schedules were tied to monthly schedules for disbursement of entitlements, and our observations were carried out over the first two weeks of each month when most of the purchases are made. Participant observation occurred over 60 days during June, July, and December, representing three months of food distribution via COREPDS.

#### 3.3 Beneficiary Interviews

During participant observation at FPSs in Raipur and Mahasamund, 30 beneficiaries were interviewed while they waited to purchase their monthly entitlements at five shops, three in the Mahasamund district (two urban and one rural) and two in Raipur city. One of the shops in Raipur was selected because it was a woman-run organization and had exhibited high performance over the previous year. The second Raipur shop we observed was experiencing difficulties in retaining beneficiary customers.

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3. Criterion sampling refers to the study of cases that meet some predetermined criterion of importance and that are likely to be rich in information (Patton, 1990).

### 3.4 Document Analysis

All the authors of this article reviewed policy papers, research articles, and presentations from the NIC, the Planning Commission of India, and the governments of India and Chhattisgarh to construct a timeline of key administrative and technological interventions in Chhattisgarh's PDS and to obtain comparative data on the "lifting" of commodities before and after COREPDS. Participant observation and interviews yielded memos and key quotations representing challenges faced by beneficiaries, their interpretation of the administrative reforms, and their experiences with smart cards. Usage statistics were extracted from an SQL database back-up which contained transaction records from the Chhattisgarh State Food, Civil Supplies & Consumer Protection Department and the NIC, Raipur.

## 4. State-Level Reforms in the PDS: Chhattisgarh's Turnaround

COREPDS is the most recent installment of technological interventions in food security that have accompanied political and administrative contingencies in Chhattisgarh. Formed in 2000 from the poorer, rural, and tribal districts in the state of Madhya Pradesh, Chhattisgarh was considered a textbook illustration of PDS failure, demonstrating the paradox of poor household access to food where production and availability were in surplus. Over the next eight years, local ICT-based interventions began as a supplementary response to a number of political decisions that benefited and inhibited citizen food access. In 2001 the Congress Party-led state government sought to increase FPS coverage through privatization (Krishnamurthy et al., 2014). The following year the government began participating in the Decentralized Procurement Scheme, purchasing grains directly from Chhattisgarhi farmers. From 2002–2004, paddy procurement nearly doubled to almost two million metric tons (Krishnamurthy et al., 2014). Meanwhile, the number of FPSs doubled to 8,637, with approximately 58% of shops in Chhattisgarh being privately owned in 2004. Shops reported near 100% purchase of commodities even as their density remained below 1 per 1,000 people (Krishnamurthy et al., 2014).

Saddled with widespread complaints over corruption and grain diversion, the newly elected Bharatiya Janata Party (BJP) government initiated a number of technological interventions to address the logistical problem of storing and processing procured grain and to increase transparency in food distribution. Over the next five years, the government implemented end-to-end computerization of the PDS supply chain, implementing systems that tracked the volume of grain procured, computed payments to over one million farmers, created electronic records of grain processors, and automated FPS allotments. Call centers and text message services were established to receive complaints and share grain movement reports with registered citizens. Despite low usage, these technocratic initiatives received media attention and bolstered the chief minister's clean image, earning him the moniker of *chawal-wale baba*<sup>4</sup> among the media and large sections of the populace. To the government's good fortune and in contrast to traditional patterns of succession in civil administration, senior bureaucrats who supervised the computerization of procurement continued their predecessors' efforts by extending computerization to storage, processing, and distribution. As one engineer working on COREPDS explained, "Chhattisgarh has been blessed by a succession of bureaucrats who remained committed to the goal of making technology work, regardless of whether the government worked."

In 2007, a pre-election year, the BJP government initiated the *Mukhyamantri Khadyann Sahayata Yojana*<sup>5</sup> scheme, adding two million individuals to the list of those eligible for food access at BPL (below-poverty-line) prices. Digitization of beneficiary records followed as a necessary step to accomplish the political goal of increasing the number of households eligible for food assistance at the lowest possible prices. Riding against an anti-incumbency wave, the BJP government returned to power in 2008 with only a 2% margin of the votes cast. As some beneficiaries stated, "Raman Singh returned to power because he took food and fuel to the people." In 2011 the Supreme Court of India recognized Chhattisgarh's progress toward achieving food security, calling for the Chhattisgarh model to be replicated across India. Soon, states such as Haryana and Gujarat adopted the particular technocentric vision for the PDS promulgated by the Chhattisgarh administration. A combination of populist posturing and consistent bureaucratic implementation of populist policies helped

4. *Chawal (rice) wale (of) baba (saint) or 'saint of rice' is an epithet Chhattisgarh's Chief Minister Dr. Raman Singh acquired after record paddy procurement and rice distribution were achieved under his administration.*

5. *Chief Minister's Food Assistance Plan.*

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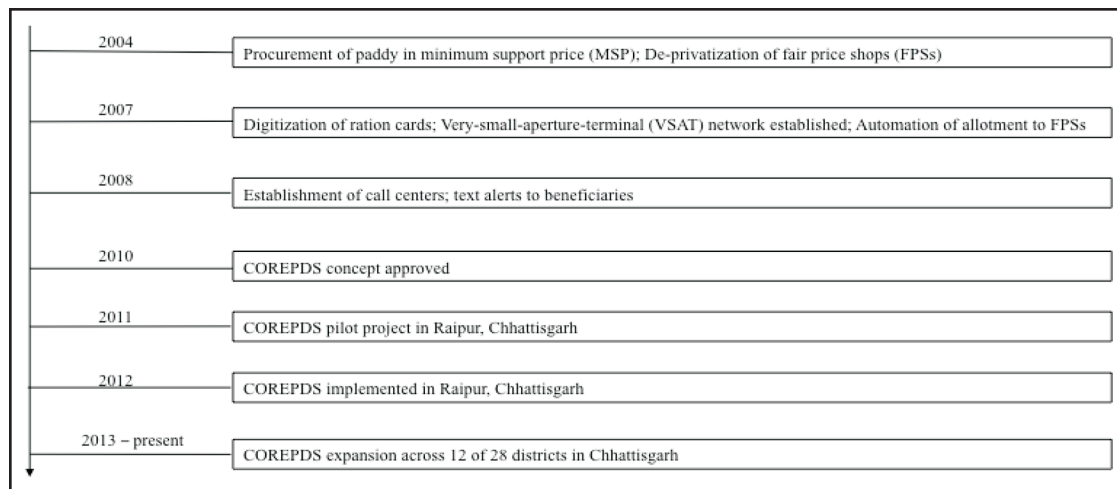


Figure 1. Timeline of technological interventions in Chhattisgarh's public distribution system.

communicate the possibility of a local technocentric solution to the problem of feeding the least nourished and most electorally attractive segment of the population. Figure 1 represents the timeline of technological interventions aimed at increasing transparency in Chhattisgarh's PDS.

### 5. Enabling Beneficiary Freedoms Through the Centralized Online Real-Time Electronic Public Distribution System (COREPDS)

COREPDS was warranted because of two areas of concern regarding effective and transparent distribution of essential commodities through fair price shops. First, several beneficiaries reported poor service during informal interactions in the period following implementation of the administrative reforms and the technological interventions described above. Second, there was evidence of proxy issues, that is, entitlements issued in the name of but not to the beneficiary. Beneficiary challenges indicated the relative lack of integration (Holden, Norris, & Fletcher, 2003) in the existing bureaucratic mechanism for updating essential information. For example, a middle-aged female beneficiary from Raipur expressed frustration because of her inability to record a change of local address at the state level: "I stay in a rented house. After I moved houses, my shop was 10 kilometers away. Who will go to the Collector's Office to change the ward? I have to travel this long distance to get goods."

The quote above suggests a lack of horizontal integration (Holden et al., 2003) that made it difficult for users to complete transactions involving agencies other than the state food and civil supplies department. Another Raipur beneficiary in her twenties reported sharing notes on her shopping experience with friends in other wards: "My shop owner underweighs items. My friend says that her shop owner weighs correctly. What can I do? I cannot change shops."

A third beneficiary, a middle-aged male, complained about losing an entire day to purchasing food at the fair price shop in Mahasamund: "Whenever I visit the shop it's closed. I have to go at least five to six times to get all the essentials."

In addition to lost wages, beneficiaries also complained about the discomforting presence of male salespersons at shops. A teenaged girl from Raipur said, "I am an 18-year-old girl. The boy who sits at the shop keeps staring at me, I don't like it. But what can I do? I can only get rice at two rupees a kilo from that shop."

Quality of service is a behavioral issue that affects beneficiaries' right to access food in a dignified, socially acceptable manner. Service quality depends on the integrity of the individual salespersons and owners and is not amenable to frequent monitoring and surveillance. The quality of service received and the possibility of diversion may depend on the social norms governing male-female interactions and that are skewed against



females. Females interacting with male salespersons carry out the majority of transactions. Societal taboos and traditional conventions regarding interactions between females and males who do not share kinship make it possible for males to be dismissive toward, or even ignore, females. Male members of beneficiary households might trade their food entitlement for cash advances from the FPS. Such cash advances are likely to be spent on goods (e.g., liquor) and services (e.g., entertainment) that are consumed primarily by men (Drèze & Sen, 2013).

If beneficiaries were empowered to reject those fair price shops that provide poor service, then FPSs might improve service delivery to retain as well as to recruit beneficiaries. FPS salespersons reported dealing with pressure from local politicians and other persons wielding influence to divert food entitlements outside the PDS. Diversion in the PDSs at any stage is only possible when proxy issues can be recorded at a fair price shop. Authenticating, recording, and storing individual transactions in real time ensures entitlements are only disbursed to the beneficiary in possession of appropriate electronic identification. Theoretically, the government could encourage beneficiaries to choose the shop from which they purchase. Lacking a centrally accessible and verifiable record of past transactions, FPSs cannot check for individual beneficiaries trying to engage in multiple transactions in the same month. In the absence of records, shops may also divert commodities by presenting unverifiable bogus transactions. Placing transaction data in the public domain facilitates public scrutiny and social auditing of transactions, allowing citizens to participate in monitoring service delivery. Transaction data also helps identify shops that lost a substantial proportion of their beneficiaries.

## 6. COREPDS: How It Works

Each FPS is provided with a point-of-sale (POS) device and a smart card operating on a general packet radio service (GPRS) network. Each BPL female head of household is provided with a smart card. The POS device reads, authenticates, and communicates the beneficiary ID to the server through GPRS to retrieve and update her food account balances. APL beneficiaries may submit a registered mobile phone number and beneficiary ID at the fair price shop to carry out a transaction using a one-time pin.

## 7. Intended Benefits of Portability

COREPDS seeks to empower beneficiaries through portability, offering each beneficiary *the right to choose the fair price shop* where she obtains her entitlements. Earlier, FPSs did not fear losing beneficiaries because they were tied to a specific shop based on their residence. Portability enables enterprising FPSs to attract customers at the expense of shops that fail to improve service delivery. Portability provides each beneficiary the freedom to choose *when and where she wishes to conduct a purchase, how much she wants to purchase* in a single transaction, and *how she wishes to authenticate* her identity. The majority of transactions are carried out by women who benefit from being able to choose shops that provide entitlements in quantities that are possible for them to physically haul. Beneficiaries may also choose to purchase the full entitlement amount in a single transaction because it saves them time that might be otherwise spent earning wages. Before COREPDS, beneficiaries lost valuable time waiting between 2–6 hours at shops. PDS subsidies are equivalent to approximately 750 rupees (approx. US\$11.40) per BPL household per month. Daily wages for a BPL citizen range from 90–200 rupees (US\$1.40–3.00). By purchasing entitlements at the shop of her choice, the beneficiary is also able to choose the timing of the purchases without having to worry about being harassed by a male shop owner or salesperson.

COREPDS enables beneficiaries to authenticate across multiple use cases. Similar to large-scale e-infrastructure projects, a small percentage of genuine beneficiaries may not possess smart cards because they could not attend a distribution camp or because they have lost the smart card and not yet received a duplicate. Weighing the need to ensure that such genuine beneficiaries receive their entitlement over the risk of proxy issues, COREPDS allows beneficiaries to purchase commodities from the FPS linked to their residence by sharing their beneficiary ID. COREPDS point-of-sale machines can also authenticate *Rashtriya Swastha Beema Yojana* (RSBY<sup>6</sup>) smart cards. RSBY cards and COREPDS smart cards are linked to the unified database of ration

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6. National Health Insurance Program.

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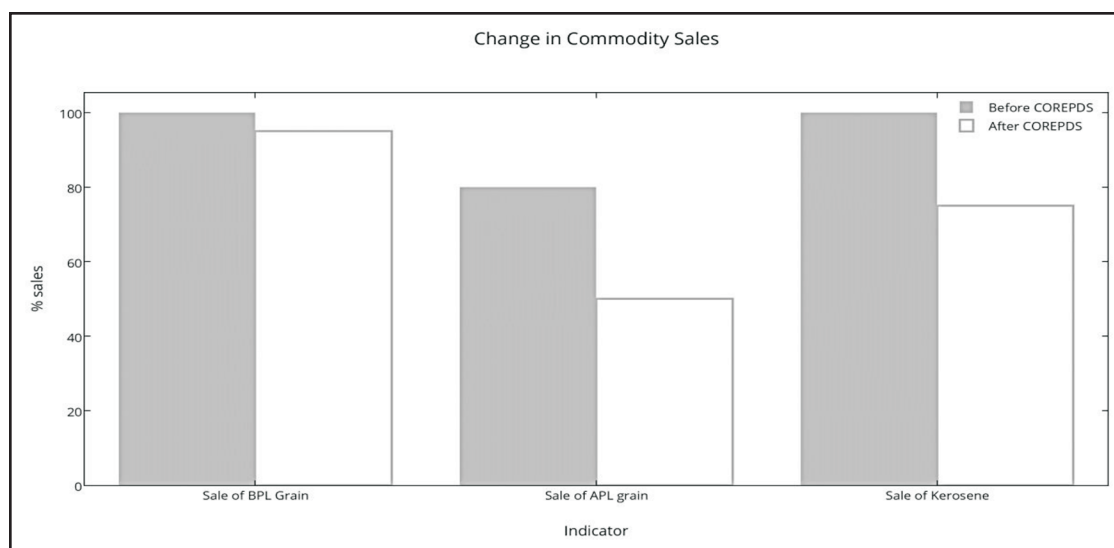


Figure 2. Change in commodity sales before and after COREPDS (adapted from CGFCSC, 2012).

cardholders, allowing either card to be employed for authentication and avoiding duplication of future effort. COREPDS functions against the interest of shops that depend on diversion of grain to generate profits. There remains a risk that the FPS manager intentionally tries to discredit the technology or claims lack of connectivity. Offering portability mitigates this risk by allowing beneficiaries to make purchases at other shops. Figure 2 demonstrates the decrease in proportion of entitlements “lifted” by APL and BPL households, indicating a reduction in diversion of food grains from the PDS. Before COREPDS, fair price shops would report 99–100% sales on their reports. After the introduction of COREPDS, reported sales figures have declined (CGFCSC, 2012). The sharp decline in reported sales of APL grain indicates a reduced diversion of grain that typically remains unclaimed.

However, the utilization of portability may differ, depending on beneficiaries’ socioeconomic status and geographical location. BPL beneficiaries may be more likely than APL beneficiaries to experience circumstances such as migrant work or discrimination during service delivery. In light of these possible differences, we ask:

RQ1: How does portability utilization vary in response to beneficiaries’ geographic location?

RQ2: How does portability utilization differ across beneficiaries’ socioeconomic status?

## 8. Measuring Portability Utilization

### 8.1 COREPDS database

The COREPDS database is designed along the lines of a banking database. Beneficiaries, FPSs, and commodity purchases are analogous to account holders, branches/ATMs, and banking transactions (e.g., deposits and withdrawals). The relational database comprises 46 data tables that record static attributes (e.g., beneficiary’s ID and original FPS ID) and dynamic details (e.g., beneficiary’s issuing FPS ID, date, and time of issue) on beneficiaries, shops, and transactions.

Beneficiaries’ portability utilization and the concurrent effect of beneficiaries’ movements on FPS sales were measured by querying and combining data across the primary transaction table, the beneficiary, and FPS master tables into a single portability table, *Portab*, using SQL Server Management Studio. Data in the *Portab* table included 3,927,406 records, which represented the sum of transactions from 2011–2013. Each row in *Portab* corresponds to a unique beneficiary transaction with seven columns, RC\_Number, RC\_Color, BenUrbRur, Issue\_FPSID, Orig\_FPSID, MONTH\_Issue, YEAR\_Issue, explained next.



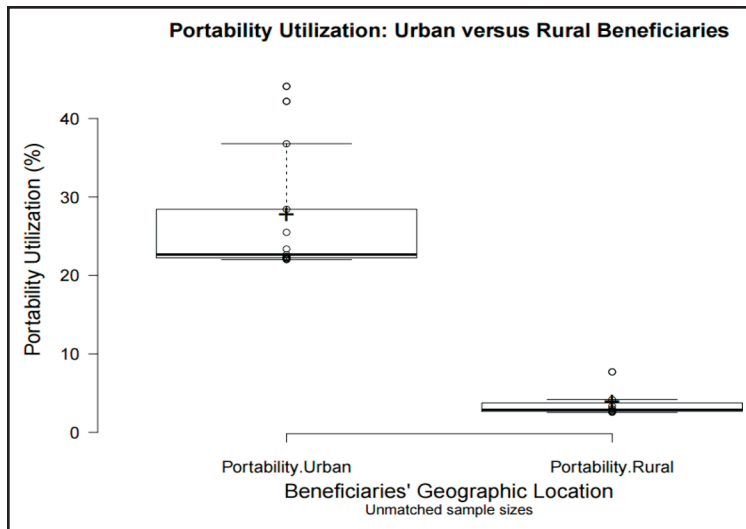


Figure 3. Portability utilization among urban and rural beneficiaries.

the beneficiary's original, or "home," FPSID. Beneficiary, FPS, and transaction data were queried over the period August 2012–August 2013 when COREPDS was fully operational with minimal disruption in network and the maximum availability of portability to citizens. COREPDS's use in rural areas began in January 2013. Data for use by rural beneficiaries covers the period January 2013–August 2013 unless otherwise stated.

Figure 3 depicts portability utilization (number of beneficiaries using portability/number of beneficiaries served) by beneficiaries in urban and rural areas. In Figure 3 we see that portability utilization is higher in urban areas (Mean = 24.2%; Median = 22.7%; Standard Deviation = 0.08) than in rural areas (Mean = 3.6%; Median = 2.9%; Standard Deviation = 0.02). 36.8% of urban beneficiaries utilized portability in August 2012, decreasing to 22.2% in August 2013. Portability utilization by rural beneficiaries decreased from 7.7% to 3% between January–August 2013. We note that the remaining beneficiaries who continued to transact at their "regular" FPSs were doing so by choice rather than compulsion. In response to RQ1 and RQ2, we explain trends observed in portability utilization by further analyzing how utilization varied in response to beneficiaries' socioeconomic status.

A Mann-Whitney test indicated that portability utilization was greater for urban areas (Median = 22.7%) than for rural (Median = 2.9%);  $U = 0$ ;  $p < 0.001$ ;  $r = 0.81$ , indicating the strong effect of geographic location on portability utilization. These results suggest that beneficiaries' geographic location affects their portability utilization. Specifically, a higher percentage of beneficiaries located in urban areas take advantage of portability. While these results are intuitive, given that urban locations contain a greater number of FPSs than rural locations, it is interesting to note that more than 3% of rural beneficiaries served (approx. 118 families) choose to exercise their right to purchase rations at a different location. There are at least two possible explanations for rural beneficiaries' decision to utilize portability. First, rural beneficiaries who have migrated for work may find it convenient to purchase food where they are located. Second, rural beneficiaries reported that the quality of service received and the quality of infrastructure are often higher outside the village than inside it. As one Mahasamund beneficiary reported:

[Buying rations] is a task that we have to do once a month. Transporting kerosene and a [35-kg] bag of rice is less cumbersome on the highway than carrying it on the broken roads within the village. We are able to pick up most of the ration and complete other work in town on the same day. The delivery of ration to our village is not always as quick.

Infrastructure problems may also extend to connectivity issues. While we did not collect real-time data on network connectivity during transactions across rural and urban locations, it may be that GPRS connectivity was

Each household has a unique RC\_Number. RC\_Color records the beneficiary's ration card color, which corresponds to the state and central governments' classification of households into socioeconomic categories. Ration card colors correspond to two primary socioeconomic categories: households that have been identified in the 1991, 1996, or 2002 BPL surveys as either *Below Poverty Line (BPL)* or *Above Poverty Line (APL)*.

BenUrbRur records whether the beneficiary location is rural or urban. ISSUE\_FPSID records the ID of the FPS where a beneficiary completed a transaction in a given month (MONTH\_Issue) and year (YEAR\_Issue). Orig\_FPSID refers to

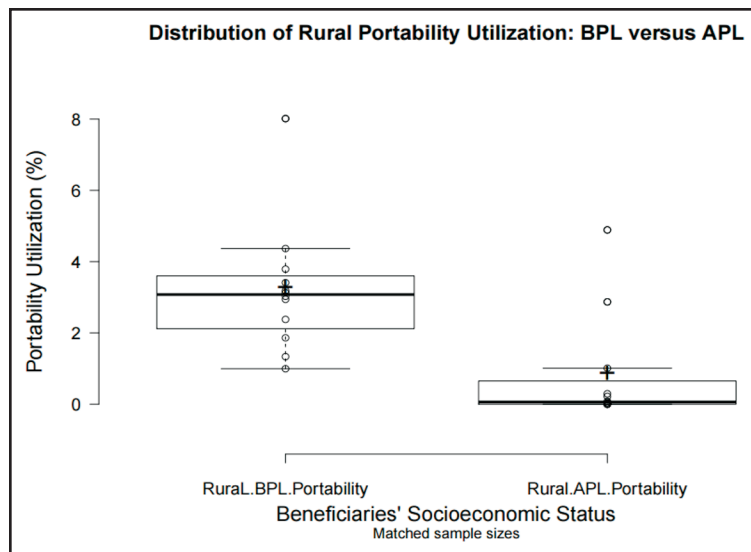


Figure 4. Portability utilization by rural BPL and APL beneficiaries.

socioeconomic status, a Wilcoxon Signed-Ranks Test was conducted to compare portability utilization for BPL and APL rural beneficiaries on matched samples representing portability utilization over the period January 2013–December 2013. The test indicated that portability utilization was greater among rural BPL (Median = 3.07%) households than among rural APL (Median = 0.06%) households;  $Z = -3.06$ ;  $p < 0.01$ ;  $r = -0.62$  (see figure 4). These results suggest that rural beneficiaries' socioeconomic status does affect their portability utilization. Specifically, a higher percentage of BPL beneficiaries located in rural areas use portability as compared to their APL counterparts.

Similarly, among urban beneficiaries, portability utilization was observed to be higher among BPL beneficiaries than APL beneficiaries (see Figure 5).

A Mann-Whitney U test indicated that portability utilization was greater among urban BPL households (Median = 29.7%) than urban APL households (Median = 13.1%);  $U = 99.5$ ;  $p < 0.01$ ;  $r = 0.67$ . These results suggest that urban beneficiaries' socioeconomic status does affect their portability utilization. Specifically, a higher percentage of urban BPL beneficiaries use portability compared to their APL counterparts. Table 2 displays median values from figures 4 and 5, representing portability utilization across the four categories of geographic location and socioeconomic status.

Figure 6 depicts how portability utilization has varied in response to the expansion of COREPDS in urban areas. We see that portability utilization by urban BPL beneficiaries shows a slight positive trend in response to the number of beneficiaries served, whereas portability utilization by urban APL beneficiaries decreases in response to an increase in the number of beneficiaries served. While Figure 6 suggests that beneficiaries' portability utilization varies in response to socioeconomic status, it may be the case that portability utilization decreases in response to an increase in the denominator term "number of beneficiaries served." An Ordinary Least Squares regression analysis was carried out to test the effect of the independent variables "socioeconomic status" and "number of beneficiaries being served" on the dependent variable "portability utilization." Results indicate that the two variables together explain 53.8% of the variance in portability utilization ( $R\text{-square} = 54.7$ ;  $F(2, 101) = 61.07$ ;  $p < 0.001$ ). Socioeconomic status significantly predicted portability

lower in rural areas than in urban. Interviews with FPS salespersons suggested that they did face some difficulty in uploading records. For example, some salespersons reported that they uploaded transaction records at particular times when they observed connectivity was "strong." Field engineers also reported troubleshooting unique complaints when connectivity was present yet inaccessible, such as when large numbers of beneficiaries crowded around the POS machine. One FPS salesperson reported: "I climb the roof every evening to upload offline transactions because that's where I get the best connectivity."<sup>7</sup>

To further investigate differences between rural beneficiaries'

7. COREPDS is designed to allow a limited number of transactions (three for a beneficiary; 100 for an FPS) to be completed offline and stored on FPS and beneficiary smart cards. Transactions are updated to the server when connectivity resumes.

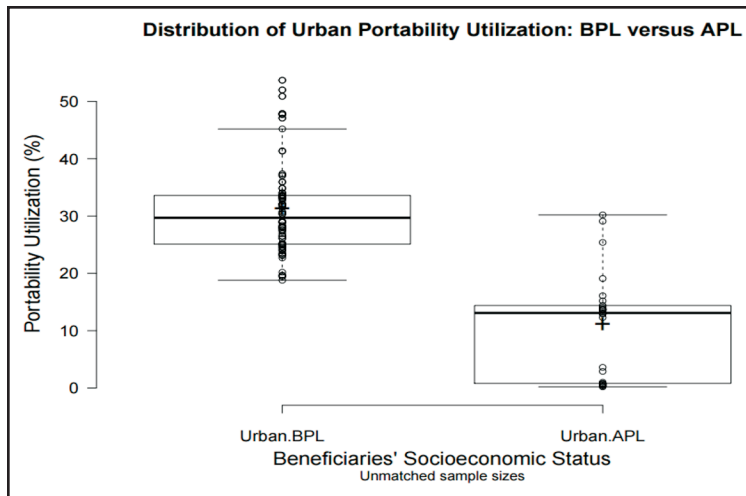


Figure 5. Portability utilization by urban BPL and APL beneficiaries.

Table 2. Median Portability Utilization Across Geographic Locations and Socioeconomic Status.

	Urban	Rural
BPL	29.7	3.07
APL	13.1	0.06

utilization ( $\beta = -20.13$ ;  $t(103) = -11.01$ ;  $p < 0.001$ ), whereas the number of beneficiaries served did not significantly predict portability utilization ( $\beta = -1.64E-06$ ;  $t(103) = -0.05$ , ns).

## 8.2 Effect of Portability on Intermediaries' Participation in Food Distribution

Figures 7a, 7b, and 7c depict the independent variable "average number of trips made by beneficiaries" (calculated as the ratio of the number of transactions to the number of beneficiaries served per month) decreasing in response to increases in these dependent variables: "number of beneficiaries served," "number of transactions," "number of FPSs." Average number of trips decreased from 1.84 to 1.43, while the number of FPSs increased from 145 in August 2012 to a peak of 302 in March 2013 before decreasing to 289 in August 2013. Change in average number of visits to FPSs serves as a

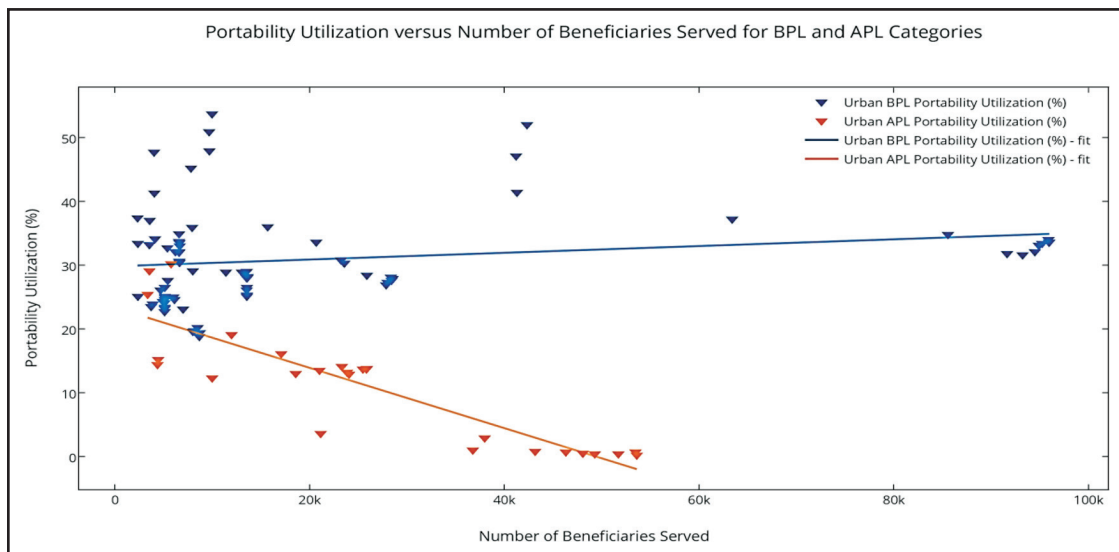


Figure 6. Variation in urban portability utilization trends by socioeconomic status.

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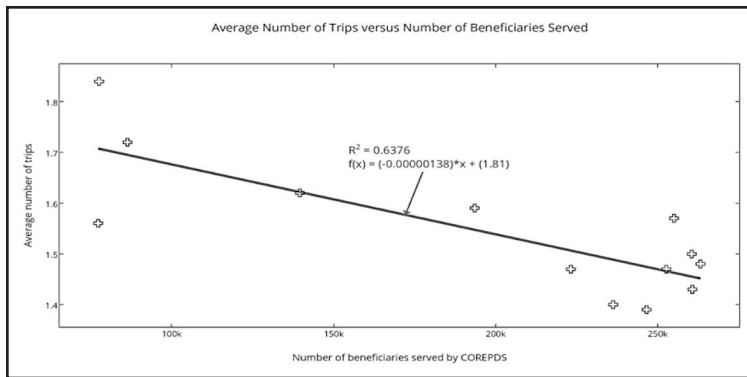


Figure 7a. Average number of trips as a function of the number of beneficiaries served.

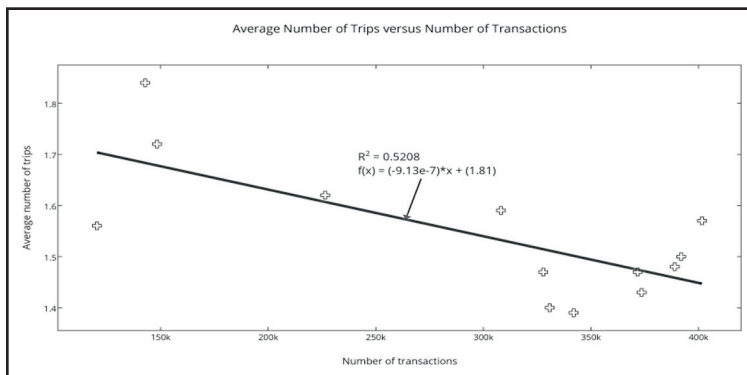


Figure 7b. Average number of trips as a function of the number of transactions.

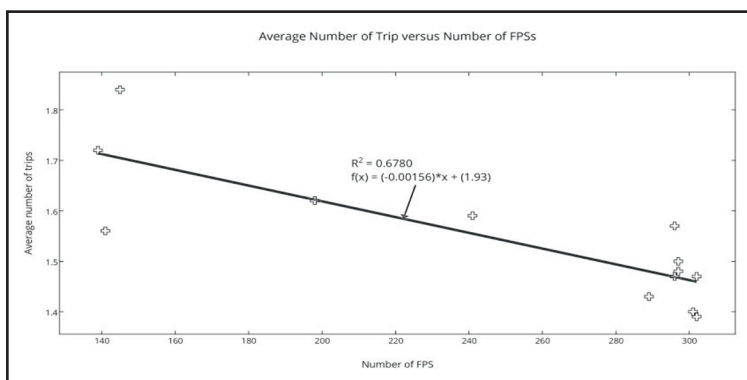


Figure 7c. Average number of trips as a function of the number of FPSs.

measure for improvement in service delivery. Beneficiaries were frequently forced to visit FPSs multiple times to obtain different commodities. The ability to purchase entitlements in fewer visits saves on costs and time lost to travel. Owing to its odor, kerosene is often sold separately as many beneficiaries do not want to buy and transport kerosene with food grains. That the average number of trips is fewer than two suggests that beneficiaries do not have to make multiple trips to receive their entitlements.

Figures 8a, 8b, and 8c represent longitudinal and spatial trends on the effect of portability on FPS performance. Figure 8a is a heat map that shows performance over the period August 2012–August 2013 for 30 FPSs, representing varying levels of performance in Raipur city. The map's colors represent the number of beneficiaries gained or lost each month. Red cells indicate the FPS lost more sales to other shops than it attracted. Yellow cells indicate the FPS broke even in terms of the number of beneficiaries gained and lost. Green cells indicate the FPS attracted more beneficiaries than it lost to other shops. Many FPSs exhibited a fairly consistent level of positive (e.g., #100, #172) or negative (e.g., #177, #191) performance. Performance at some shops (e.g., #52, #189, #63) worsened, while others (e.g., #38, #86, #65) improved service delivery over the 12 months when portability was functional and consistently available in Raipur city.

Figures 8b and 8c clarify the performance averaged over 12 months and the locations of FPSs in Raipur city. Larger dark green circles represent shops that were successful in expanding operations. Smaller light green and yellow circles indicate shops that exhibited moderate gains in the number of beneficiaries served. Small orange and red circles designate shops that lost business since portability was offered. Figure 8b suggests that the

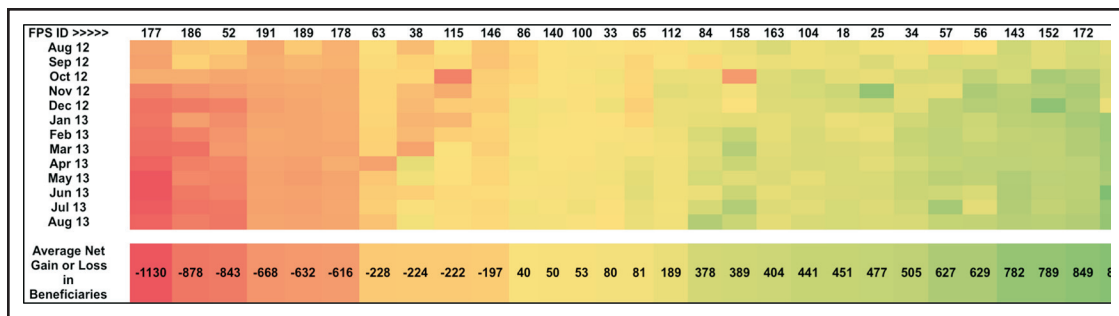


Figure 8a. Performance of FPSs over time in Raipur city.

most successful shops were located along arterial roads around the city center, with moderate performers located along the city periphery. Higher population and population density nearer the city center and proximate to major thoroughfares appear to offer an obvious accessibility advantage. Figure 8c is a snapshot of a zoomed-in region around the city center and reveals several underperforming shops located in the vicinity of other, more successful FPSs. Given the location advantage enjoyed by all the shops plotted in the snapshot and the relatively large number to be found in each other's vicinity, it is reasonable to speculate that the positive or negative performance of the shops in Figure 8c is likely due to the quality of service they offer to beneficiaries. Indeed, one of the successful shops (#78) is operated by Ms. Roshni Sahu, a member of a women's self-help group that has more than quadrupled the number of beneficiaries being served at their shop located near *Raja Talab*, a lake in the heart of Raipur. Ms. Sahu remarked:

COREPDS generated competition among FPS operators. The competition has forced shops to care about the quality of food, offer service with a smile. There are five to 10 females working at any point in time to make sure the queue does not build up. We measure precise amounts, do not just provide but also explain receipts and willingly issue smaller amounts that are easier to carry.

Cells are colored in response to the absolute number of beneficiaries gained or lost in a given month. Red cells indicate an FPS has lost beneficiaries. Yellow cells indicate moderate gains or equilibrium. Green cells indicate strong gains in the number of beneficiaries served. Figure 8a suggests that FPS performance varied considerably over the 12 months from August 2012–August 2013.

Large green circles identify shops with the highest gain in absolute numbers of beneficiaries. Smaller circles shaded in light green and yellow represent shops that enjoyed moderate gains. Small circles shaded in orange or red represent FPS locations that experienced steep losses in the number of beneficiaries served. Figure 8b indicates that shops located close to the city center performed better than those located toward the outskirts. Figure 8c shows a zoomed-in section of the city center. Small red circles in Figure 8b indicate shops that performed poorly despite their location near the city center. Such shops may be investigated further for the quality of service provided.

## 9. Discussion

Contemporary civil society discourse on ICTs and development tends to emphasize deterministic approaches that seek scale and technology as twin solutions to wicked problems such as hunger and poverty. Governmental responses include mega e-infrastructure projects such as Aadhaar/UID that prioritize the state's need to enumerate citizen identities in electronic form at the national level. Such mega e-infrastructure projects are difficult to scale and require a considerably greater expenditure of human and financial capital. They also depend more on sustained legitimation in the public sphere than do less complex regional interventions such as COREPDS. COREPDS prioritizes Chhattisgarh's citizens' needs over the state's vision for a nationally "bankable" database of citizens. It builds organically off previous state policies, including digitization of beneficiary records and computerization of supply-side processes.

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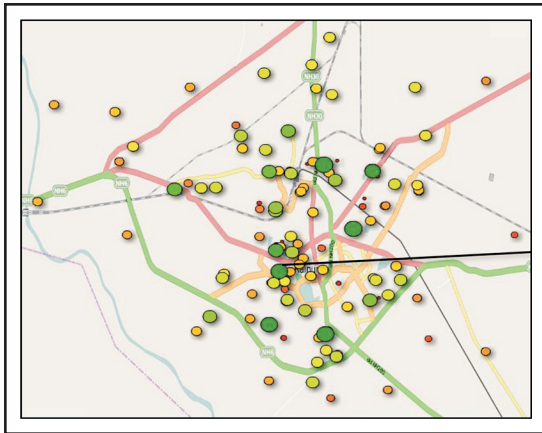


Figure 8b. FPS performance in Raipur city.

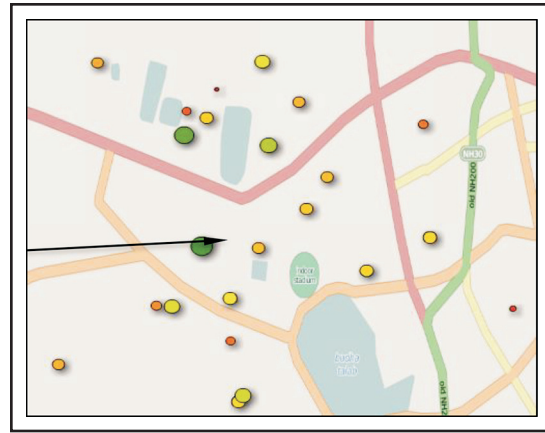


Figure 8c. Zoomed-in section that indicates poorly performing FPSs their central location.

Arguments for UID's utility in the PDS depend on four claims (Khera, 2011a). First, UID claims to address exclusion errors by helping eligible families that lack identity proof to claim food access. Despite the lack of reliable estimates, many Indian households possess some form of identity documentation such as voter IDs or cards representing enrollment in state and national welfare schemes. Data shared by the UID in response to a right-to-information affidavit indicate that 99.7% of the 850 million numbers registered were allocated to individuals who possessed at least two forms of ID (Khera, 2015). These statistics suggest that UID has thus far duplicated past enrollment efforts and has yet to document those who lack an ID of any sort (Khera, 2015). During data collection, we observed several beneficiaries who displayed no fewer than three different cards representing their enrollment in voter rolls, COREPDS, or RSBY, among others.

Second, UID has claimed it increased PDS efficiency by preventing fake issues and duplicates. Eliminating fake issues under UID requires the use of Aadhaar cards. These tasks have already been accomplished in states such as Chhattisgarh that digitized ration cards. The incidence of fake issues, including "ghost" cards and duplicates, is estimated at between 2–13% (Radhakrishnan [2010] in Khera, 2011a). Local e-infrastructure projects such as COREPDS offer a tested, frugal, flexible, and cost-efficient alternative to "de-duplication" and elimination of fake issues.

Third, UID claims to enable "last mile" authentication by linking beneficiary transactions to monthly sales registers and prevents diversion to the open market and underselling to beneficiaries. Biometric authentication makes demands on users by requiring them to have verifiable biometrics. For intermediaries, biometric authentication is a higher-cost means of ensuring compliance through coercion. In contrast, COREPDS requires intermediaries to only install its free software and allows them to obtain lower-priced hardware at subsidized costs. While we have surveyed and interviewed intermediaries regarding their perceptions and attitudes toward COREPDS (see Chopra & Rajan, 2016), we limit our attention here to measuring shop performance through usage statistics, given our focus on measuring portability usage rather than perceptions among various stakeholders. Biometric authentication is more difficult for particular ethnic groups, the elderly, and manual laborers (Nanavati, Thieme, & Nanavati, 2002). Given that the primary beneficiaries of the PDS are BPL citizens likely to engage in physical labor, biometric authentication may increase authentication times and false negatives.

Fourth, UID claims to introduce food access portability. UID-based biometric authentication systems struggle to adapt to multiple portability use cases commonly encountered during PDS transactions. COREPDS enables true benefits portability by enabling proxy withdrawals, an essential strategy for households to claim entitlements. Elderly, single, disabled, and sick beneficiaries may be unable to visit FPSs and, thus, request kin, friends, or neighbors to transact on their behalf. BPL families often send one person to collect entitlements for three or four families to save time and money. UID seeks to eliminate proxy withdrawals by requiring the



beneficiary to be physically present at the time of transaction. COREPDS allows two families to be associated with each beneficiary ID. Once a family is added, its members can get the other beneficiaries' PDS entitlements by using the actual beneficiary's smart card and authenticating their own identity.

Large-scale technology design and implementation projects such as COREPDS require a perspective that empowers users rather than controls misuse. We ask whether biometric authentication is required to transfer subsidies equivalent to a few hundred rupees every month. Proxy issues are easily checked using a what-you-have rather than a what/who-you-are type of authentication. Cases wherein cards are forcibly kept with the FPS, lost, or stolen constitute a small percentage of diversion. Biometric means of authentication may inconvenience and possibly exclude genuine beneficiaries who, lacking verifiable biometrics, are asked to re-enroll in the UID. The same risk of fraud applies to credit card transactions.

COREPDS enables community participation through social auditing by involving citizens who register their mobile phone numbers on the COREPDS website to receive a text message with dispatch details, including the truck license plate number, names, quantities of PDS commodities being transported, and the date and time of dispatch and delivery. Citizens are also able to register complaints at the website or contact a call center using a toll-free number and view transaction data through publicly accessible websites.

The cover of a 2012 NIC report that justifies the need for portability states:

A person produces the same commodities in the same way and ends up with the same income and buys the same goods, she may still have very good reason to prefer the scenario of free choice over submission to order. (Sen, 1999, p. 27)

Sen (1999) suggests that development interventions must be evaluated in terms of *how* and not only whether they achieve final outcomes of interest. The primacy of Sen's quote in COREPDS documentation suggests that, unlike UID, COREPDS prioritizes citizen freedoms over the state's needs. COREPDS is predicated on the Senian argument that development has a normative, moral objective to increase the freedom for individuals to choose (Kleine, 2010; Sen, 2005). The focus on conceptualizing and promoting food access via portability addresses the practical question of empowering households by affording them agency: the freedom to choose when, where, and how to purchase food. By *agency* we refer to the ability of individuals to form and realize goals in the interest of improving personal well-being or to exercise the freedom to choose ways of *doing* or *being* that they value (Sen, 2005).

UID is envisioned as a flexible platform on which government may integrate various services to deliver benefits to citizens across multiple service domains including nutrition, health, education, and employment. Yet, UID's flexibility requires greater technological and organizational complexity and integration, whereas the need in a single-service vertical such as PDS is for transactional services that are well integrated with back-end processes. Beneficiaries may be unable to procure their entitlements using UID where connectivity problems are frequent. Offline systems where transactions are temporarily stored in a smart card and later uploaded to servers are better suited to locations where connectivity is intermittent. We reiterate that an affirmation of commitment to expanding citizen freedoms does not depend on the use of technology. Gujarat's PDS offers portability, but requires beneficiaries to make two trips, first to authenticate their biometric identities at government-operated kiosks and obtain bar-coded coupons and second at their FPS (CGFSC, 2012). The back-end process remains because the FPS must manually submit collected coupons to declare sales and update stock levels. The PDS in Haryana does not offer portability at-will as beneficiaries are restricted to a single FPS and must request a change of FPS before exercising portability. Portability in COREPDS fosters higher quality service and a competitive environment in a deprivatized market by allowing beneficiaries to vote with their feet.

Our analysis of geography's role in enabling mobility suggests that urban beneficiaries are better placed than rural beneficiaries to receive access to ICTs that enable agency. Urban areas such as Raipur, Durg, and Rajnandgaon received access to food via COREPDS earlier than rural districts such as Mahasamund. Portability utilization was significantly higher among urban households. In addition to receiving access earlier, the higher density of shops in urban areas may make it easier for urban beneficiaries to employ portability. Finally, the

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significantly lower utilization of portability by rural beneficiaries is a clear indication of the problem of inequity of access to physical infrastructure. Paradoxically, our qualitative data suggest that some rural beneficiaries might be motivated to use portability because of the higher-quality roads between rather than within villages.

Text and technology literacy may not be an insurmountable impediment to beneficiaries who wish to exercise portability. BPL beneficiaries who, arguably, possess lower literacy levels demonstrate higher portability utilization than APL beneficiaries across rural and urban areas. Our data confirm that APL beneficiaries exercise very low levels of PDS access. Median values reported in Table 1 suggest between 89% (in urban areas) and 99.5% (in rural areas) of APL transactions continue to occur at the beneficiary's "home" shop, suggesting that awareness of policy reforms is higher among BPL beneficiaries. Assuming that service quality motivates a beneficiary's decision to use portability, it appears that service quality is more important to BPL beneficiaries than APL. Higher BPL portability utilization may also be driven by BPL users' needs than by greater awareness.

The expansion of user freedoms assumes importance for the sustainability of COREPDS. At the least, technologies—ICT-based or otherwise—must not be seen as inconveniencing the user. Automating FPS transactions without enabling portability will inconvenience beneficiaries, but will have a marginal impact on diversion. Absent automation a beneficiary may be denied service in two cases: when the shop is closed and when stocks are unavailable. Automation without portability adds three more instances wherein a household may be unable to access food: (1) when the shop is open but lacks GPRS connectivity, (2) when the shop experiences interruptions in power supply, or (3) when the operator is absent. We note that biometric and nonbiometric technologies remain susceptible to deception, collusion, and extortion during benefits transfer (Khera, 2011b).

## 10. Conclusion

Examining the recent history of technocentric PDS reforms, we find that state-level ICT interventions depend on political exigencies for initiation and on bureaucratic support for sustained implementation of interventions that expand user freedoms. We have documented how Chhattisgarh's government has sought to empower households through portability, enabling them to choose when, where, and how they access their food entitlements. Our findings lead us to suggest that high levels of accountability in food grain movement are obtained through COREPDS. COREPDS makes the same demands on FPS accountability as UID, but without the corresponding constraint of mandating individual authentication during each transaction. The sustainability of large-scale ICT-based interventions requires the expansion of user freedoms through integration of front- and back-end procedures, a process shaped by political exigencies and bureaucratic will rather than technological complexity. ■

**Prashant Rajan**, Assistant Professor, Department of English, Iowa State University. prajan@iastate.edu

**Shweta Chopra**, Assistant Professor, Agricultural and Biosystems Engineering, Iowa State University. schopra@iastate.edu

**A. K. Somasekhar**, Technical Director, National Informatics Centre, Chhattisgarh, India. som@nic.in

**Chad Laux**, Associate Professor, College of Technology, Purdue University. claux@purdue.edu

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