Alternatives to Aadhaar-based Biometrics in the Public Distribution System

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States across the country are taking steps towards providing digital identities to beneficiaries of their public distribution systems. In doing so, the use of Aadhaar-based biometrics seems to be the preferred choice of method. However, several other methods exist for the same and have been adopted by different states at different points in time. States currently embarking on the journey of providing digital identities to their beneficiaries might benefit from evaluating all available alternatives before adopting a suitable method.

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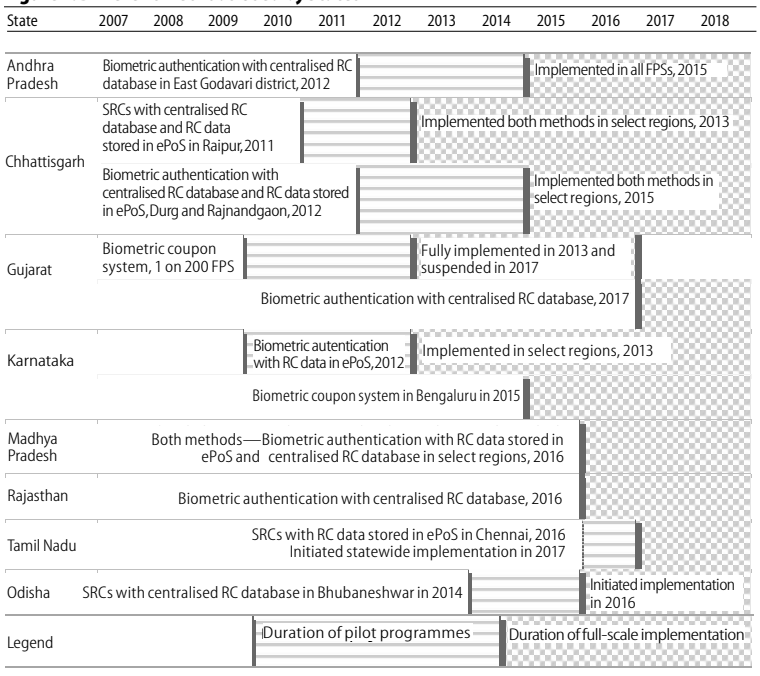
The Indian public distribution system (PDS) has witnessed several technology-driven performance improvement initiatives over the last decade. The main motivation behind these initiatives is twofold—reduce leakage of grains into the open market, currently estimated at roughly 42% of total grains disbursed through PDS (Drèze and Khera 2015) and ensure better availability of grains to genuine beneficiaries. One such performance improvement initiative adopted by several states is using digital identities to authenticate beneficiaries. With the advent of Aadhaar (India's unique biometric identity project), states are increasingly adopting Aadhaar-based biometrics to authenticate beneficiaries. This adoption has faced severe criticism from both researchers and activists, on the grounds of the method's cost-efficiency and performance (Khera 2011b, 2017; Drèze 2017; Press Trust of India 2017; Dang 2017; Ramaswami and Kotwal 2018). Therefore, it is important to note that there exist other methods that can achieve similar outcomes. In fact, these other methods have been adopted by states such as Chhattisgarh, Gujarat and Karnataka at different points in time.

In this article, we analyse these other methods to identify possible alternatives to Aadhaar-based biometric authentication. We present a conceptual framework to classify the different methods along three dimensions—(i) mode of authentication, biometric or non-biometric, (ii) source of authentication, central database-connected through internet or locally stored data in the point of sale (EPOS) device, and (iii) frequency of authentication, at every transaction or once for a predefined number of transactions. These methods are qualitatively evaluated for their efficacy in decreasing grain leakages and ensuring better availability of grains. The evaluation is done separately for two steps involved in the process of beneficiaries receiving their entitlements—first, the registration step where the beneficiary is enrolled into the PDS and second, the transaction step where the beneficiary claims their monthly entitlement from a Fair Price Shop (FPS).

While rigorous quantitative impact evaluations are needed, our analysis suggests that most benefits in performance improvement can be achieved by using biometric identification during the registration step. Mandating beneficiaries to provide their biometrics at the time of transaction is not necessary. For the transaction step, we show that different combinations of mode, source and frequency of authentication can be chosen based on the prevailing contextual realities, such as the budget available for implementation and maturity of

Figure 1: Different Methods Used by States



This figure depicts different methods of authentication used by states at different points in time. RC stands for ration card.

Sources: Compiled from various sources which include: Gayatri (2015); Somashekar (2014); Kumar (nd); One World Foundation (2012); Times News Network (2017); Dsouza (2013); Bageshree (2011); Radhakrishna (2016); Puri (2017); Odishatv (2017); Omne Agate (2016); Singh (2016); Mairappan (2015) and Ram (2016).

infrastructure. Given that several states are venturing into providing digital identities to their beneficiaries, this article aims to lay out various options beyond Aadhaar-based biometrics.

Background

The PDS in India has witnessed several technology-enabled performance improvement initiatives over the last decade. Typically driven by the state governments, these measures are aimed at reducing the leakage of subsidised grains into the open market and ensuring better grain availability to genuine beneficiaries. Examples of these measures include the installation of global positioning system devices on trucks carrying foodgrains in Tamil Nadu, intimation of the grain arrival status to beneficiaries through SMS in Chhattisgarh and automated online allocation of grains to the FPS in Gujarat (Ramaswami and Murugkar 2015). The Government of India (GOI) also provides regular financial and policy design support for such measures, a recent example being the financial support provided to install ePOS devices at all FPSs (Food Supplies and Consumer Welfare Department 2015).

Studies have observed a reduction in the percentage of grains leaked into the open market in the states following these measures (Himanshu 2013; Drèze and Khera 2011). Interestingly, these improvements were observed in states that traditionally had a poorly performing PDS such as Bihar, West Bengal, Chhattisgarh and Odisha. A key technology-enabled initiative undertaken by several states is the transition from using paper ration cards to digital ration cards. Use of digital ration cards is expected to provide enhanced visibility at a transaction level, thereby increasing the transparency and accountability of the PDS.

Since the inception of the Unique Identification Authority of India (UIDAI) in 2009, the GOI has been championing the digitisation of ration cards and the use of Aadhaar number in the process of doing so. Presently, the government has directed states to link existing ration cards with the Aadhaar numbers of beneficiaries and the Aadhaar number is made mandatory for obtaining a new ration card. The former is also called Aadhaar seeding. Further, the UIDAI has also recommended the collection of beneficiary biometrics, as a mode of authentication for purchasing grains at the FPS (UIDAI 2010). The collected biometric images are to be verified against a central database of biometrics called the Central Identities Data Repository (CIDR), for authentication. Andhra Pradesh and Haryana have already implemented the UIDAI-recommended method and are being followed closely by Madhya Pradesh, Rajasthan, Odisha and Gujarat, among other states.

This increasing adoption of the UIDAI recommended-method by states has been criticised by several scholars and activists. The criticism is primarily centred on the method's potential to overcome observed inefficiencies in the PDS and its cost-efficiency while doing so. In fact, noted economists R Khera (2017) and J Drèze (2016) opine that biometric authentication failures have disrupted reasonably successful systems in states that were already using some method of digital identification. Issues in accessing grains arising from poor implementation, such as incomplete Aadhaar seeding, inadequate failure reporting and backup systems, were identified in Jharkhand (Menon 2017). Transaction failures due to technical reasons, such as poor internet connectivity and EPOS machine malfunctioning, have been identified in regions such as Hyderabad and Delhi (Somanchi et al 2017; Shagun and Priya 2016). Interestingly, evidence from Jharkhand also suggests that insistence on biometric authentication may have increased corruption rather than decreasing it (Drèze et al 2017).

Therefore, it is important to note that there are a variety of methods that can be used to provide digital identities to PDS beneficiaries. For example, in Chhattisgarh, beneficiaries are authenticated by swiping an electronic chip-based card, also called a smart ration card (SRC), on an EPOS device linked to a central ration card database. Gujarat used a coupon system where beneficiaries were provided coupons that could be exchanged for grains at an FPS, post biometric verification at e-governance centres, and Karnataka used beneficiary thumbprints on a fingerprint capturing device that had all beneficiary biometric images preloaded into it.[1] Figure 1 provides the details of different methods and the indicative times when they were piloted and implemented by different states. In the following sections, we describe and classify different methods that can be used during ration card registration and transaction steps, we analyse the registration and

transaction processes to identify potential reasons for different inefficiencies in the system, and provide a qualitative analysis of the efficacy of different methods in addressing the observed inefficiencies.

Classification of Methods

The methods used for digitally identifying PDS beneficiaries by different states differ starkly in several aspects, such as the choice of technology, involvement of e-governance centres, and requirement of biometrics. Also, some states have used different methods in different steps involved in the process of beneficiaries obtaining their entitlements. There are two steps involved: the registration step where the beneficiary is enrolled into the PDS and the transaction step where the beneficiary claims their entitlement from the FPS. To classify the methods used to date in these steps, we develop a taxonomy based on three parameters—mode of authentication, source of authentication and frequency of authentication.

The mode of authentication is the medium through which the beneficiaries can identify themselves. The biometric mode of authentication captures beneficiary fingerprint images and iris scans during registration, and uses them to identify a beneficiary during transaction. In contrast, a non-biometric mode of authentication identifies beneficiaries using information such as name, father's name, age, address and occupation. This information along with the ration card number, number of family members and their individual details, is loaded onto a plastic card with an embedded electronic chip (SRC) and is provided to the beneficiaries as a mode of authentication at the time of registration. During transaction, identification is done by capturing this information by swiping the card on an EPOS machine, like a debit/credit card transaction (Somashekar 2014; Prasad 2016).

The beneficiary details captured through either method are verified against a database, where the details of all beneficiaries are stored. The beneficiary details are typically added to these databases post the registration step. We call such a database the source of authentication. There are two sources—central databases and local databases. Central databases are typically hosted on a web server and require an internet connection to pass beneficiary details from the EPOS machine to the servers for verification. In contrast, local databases are those which are preloaded in the EPOS devices. Verification is made at the same location where the beneficiary details are collected. The transaction details are captured in EPOS machines and uploaded on a central server at periodic intervals.

The frequency of authentication is the frequency at which a beneficiary must authenticate themselves with the PDS. Beneficiaries by default authenticate themselves for once at the time of registration. However, during transaction, beneficiaries can either be authenticated real time at every transaction, or can be authenticated once for an aggregated number of transactions, using the coupon system. In the coupon system, beneficiaries are issued barcoded coupons, sufficient for a stipulated period at an e-governance centre, also called the Common Service Center (CSC). The coupons include details such as commodity, price, quantity and the associated FPS. The beneficiary can claim their grains at their registered FPS in exchange for the coupon (Choithani and Pritchard 2015). We call this an aggregated frequency of authentication.

Given the above classification, there are eight methods that are possible (two types of sources multiplied by two types of modes multiplied by two types of frequencies). For the ease of recall, we propose a chain-based nomenclature, with the mode of authentication in prefix, source of authentication as infix and the frequency of authentication as suffix, for each method. For instance, the method recommended by the UIDAI will be called B-CD-RT with mode of authentication as biometrics (B), the source of authentication as CIDR, a central database (CD) and the frequency of authentication as real-time (RT). Table 1 lists these methods, their nomenclatures and states that have used/are using them in the transaction step. It is noteworthy that no state has used the methods NB–CD–AG, B–LD–AG and NB–LD–AG so far. In the following sections, we evaluate the methods described above for their ability to address prevailing inefficiencies in the PDS. We start with identifying a list of widely reported inefficiencies and analyse their root causes in the next section.

Table 1: Different Possible Methods in the Transaction Step and Their Nomenclature

Mode	Source	Frequency	Name	States
Biometrics (B)	Central database (CD)	Aggregated (AG)	B–CD–AG	Gujarat (2013–17) Karnataka (2015–present)
	Local database (LD)	Aggregated (AG)	B–LD–AG	NA
	Central database (CD)	Real time (RT)	B–CD–RT	Haryana (2017–present) Andhra Pradesh (2015–Present) Chhattisgarh (2015–present)
	Local database (LD)	Real time (RT)	B–LD–RT	Madhya Pradesh (2016–present) Karnataka (2013–present) Chhattisgarh (2015–present)
Non-biometrics (NB)	Central database (CD)	Real time (RT)	B–CD– RT	Chhattisgarh (2013–present)
	Local database (LD)	Real time (RT)	NB–LD–RT	Tamil Nadu (2017–present) Chhattisgarh (2013–present)
	Central database (CD)	Aggregated (AG)	NB– CD–AG	NA
	Local database (LD)	Aggregated (AG)	NB–LD–AG	NA

The columns in the table (mode, source, frequency and name) categorise these different modes into a framework defined by us (mode-source-frequency). NA stands for not applicable.
Sources: Same as those for Figure 1.

Identification of Inefficiencies

Four types of inefficiencies are consistently reported in the PDS: (i) classification errors, (ii) identity fraud, (iii) quantity fraud, and (iv) beneficiary dissatisfaction. Table 2 defines each of these inefficiencies. In the subsequent part of the section, we analyse both registration and transaction steps to identify the possible causes of inefficiencies in each process.

Registration: A typical process of registering a beneficiary involves two stages—document submission[2] and verification. Most beneficiaries, by dint of their profession or socio-economic status, cannot produce valid proofs of identity and income. Therefore, the Department of Food and Public Distribution (DFPD) commonly accepts attestation by self and the gram panchayat officials as the proof of a beneficiary's identity and financial status. Such attestation is subject to manipulation by a multitude of factors such as coercion of attester through illegal means, nepotism, rent-seeking by attesters, and misinforming the attesters. These manipulations can result in instances of identity fraud and classification errors. Examples include, attesting applications made in the name of fictitious beneficiaries, applications made by non-priority households as Antyodaya Anna Yojana (AAY) households, applications made by households which already have a ration card[3] and applications quoting a higher family size. Instances alluding to such manipulations by people in power have been reported (Bhardwaj 2014).

The verification of documents is done by ration card inspectors who physically visit the beneficiary. Evidently, this is a time-consuming process. A study in Kerala reported approximately 6,00,000 families not being able to access PDS as their applications were waiting in the pipeline for approval by the DFPD (Masiero 2016). Moreover, such verification is subject to the same kind of manipulations as that of attestation. In addition, new instances of identity fraud and classification errors can also be generated due to issues in management of the existing ration card database by the DFPD. For example, beneficiary details may not be removed from the central database after natural events such as the death and migration of a family member. Such instances are captured through periodic manual verifications (Food, Civil Supplies and Consumer Protection Department 2017; Chatterjee 2014). However, studies have reported the efficacy of such manual verifications being affected by political interventions and poor functioning of vigilance committees (Sharma and Gupta 2017; Khera 2011c).

Transaction: During the transaction process, the FPS owner verifies the ration card displayed by the beneficiary and provides the amount of grains they are entitled to after updating their records in a register. In this process, the manual verification of ration cards leaves scope for identity fraud through the shadow usage of cards. In fact, leakage of grains allocated to above poverty line (APL) cardholders is largely attributed to identity fraud of this kind (Drèze and Khera 2015). Estimates suggest that about 56%–67% of the APL allocation was leaked during 2011–12 (Drèze and Khera 2015). Leakage through quantity fraud and instances of dissatisfied beneficiaries are also widely reported in this step (NCAER 2015). The following section will compare the above-mentioned methods described for their efficacy in addressing the possible causes of observed inefficiencies described above.

The following sections analyse the efficacy of each parameter, mode, source and frequency of authentication individually, in addressing the causes of inefficiencies identified in the registration and transaction steps.

Registration

Mode of authentication: The likelihood of identity fraud through submission of fake documents in the registration process is comparatively lesser when using the biometric mode. This is because the data collector or the beneficiary will have to create fake biometrics to make such entries in the ration card database. Though reports of the creation of fake biometrics have surfaced recently (Pandey 2017), the likelihood and prevalence of such fraud is currently very limited. Further, the related problem of identity fraud through duplicate ration card applications can also be addressed better using the biometric mode. The DFPD verifies the applicant's demographic details against all entries in the existing ration card database.

The application is deemed as duplicate and cancelled if a match is found. This process of verification is also called deduplication. In the non-biometric mode, deduplication is text-based. Different combinations of name, address, age, father's name and so on, furnished in the application, are used to find if there exists a match. In contrast, biometric deduplication uses

Table 2: Description of Inefficiencies and Their Mapping to Processes

Type of Inefficiency	Description	Processes
Classification error	Inclusion error: non-priority households (NPHH) accessing FPS or priority households (PHHs) obtaining grains in Antyodaya Anna Yojana (AAY) category* Exclusion error: eligible PHH/AAY households not provided with a ration card	Registration (both submission and verification)
Identity fraud	Grains claimed from the FPS through false identities such as fake/duplicate ration cards, genuine ration cards being used individuals other than the beneficiary (shadow usage of cards)	Registration (both submission and verification)
Quantity fraud	Quantity of grains obtained from FPS lesser than entitlement	Transaction
Beneficiary dissatisfaction	Instances such as long wait times, shop closed during working hours, ration card not received on time, sexual harassment by shopowner	Registration (verification), transaction

* The National Food Security Act (NFSA) categorises households into priority households (PHH), non-priority households (NPHH) and Antyodaya Anna Yojana (AAY) households based on their financial status. The priority households are entitled up to 5 kilograms (kg) per person per month at the issue prices of ₹1, ₹2 and ₹3 per kg for rice, wheat and coarse grains, respectively. The AAY households can claim up to 35 kg of foodgrains per household per month at the price mentioned above, while the NPHH are excluded from such entitlements.
Source: NCAER (2015).

either beneficiary fingerprints or iris scans to find a match. Given that biometrics uniquely identify an individual, biometric deduplication emerges superior to that of text-based deduplication. Thus, the biometric method seems to offer a superior technological capability to address inefficiencies during the registration process. However, the collection, storage and maintenance of biometric data is significantly more expensive.

In addition, the success of either modes is partly contingent on the DFPD's ability to integrate the state's Ration Card Management System (RCMS) with data from other governmental programmes. For instance, an application made in the AAY/Priority Households (PHH) category can be digitally verified against the list of AAY and PHH identified by the Ministry of Rural Development, without the need for physical verification. Such integration can significantly decrease beneficiary dissatisfaction, by rationalising the need for physical verification and decreasing the time taken to process an application. Benefits of such integration have been reported by Chhattisgarh, Rajasthan and Karnataka.

In view of this, leveraging biometric data collected during Aadhaar enrolment offers a more cost-effective alternative than the DFPDs of each state collecting their own biometrics. After all, the most cost-intensive component of this method, which is the collection, storage and maintenance of beneficiary biometric data, is already being taken up by the UIDAI. Also, the DFPDs can leverage the ongoing Aadhaar linkage exercises with mobile number, Permanent Account Number (PAN), savings account and so on, to enhance the robustness of their RCMS. For instance, by linking the ration card database with the beneficiary PAN, any change in the beneficiary's financial status can be immediately reflected in the quantity of grains they are entitled to.

Source of authentication: To perform deduplication exercises during the registration process, the source of authentication by default needs to be a central database.

Frequency of authentication: The frequency of authentication during the registration process is by default real time, once at the time of registration or at the time of any modifications requested in the card. Essentially, the choice of a method during the registration step boils down to the mode of authentication only.

Transaction

Mode of authentication: During the transaction process, the choice of the mode of authentication can aggravate beneficiary dissatisfaction, due to an increase in technology-based transaction failures. Drivers for such failures could be poor internet connectivity, sporadic supply of electricity, malfunctioning of the ePOS and so on. In addition to these which are common to both non-biometric and biometric modes, choosing the biometric mode can further increase the likelihood of transaction failure, due to poor quality of beneficiary biometrics. It is established that the quality of biometrics is dependent on the age, gender and occupation of an individual (Theofanos et al 2006).

Also, the number of attempts required to capture a good quality biometric image for authentication purposes increases with age. This means that senior citizens could either be at the risk of being denied ration for the month after the first failed attempt, or at the risk of increasing the wait time for others in the queue. This is also true for daily wage labourers and farm workers, as their fingerprint quality deteriorates with time due to the nature of their profession. Therefore, non-biometric modes of authentication offer a more technologically robust option during the transaction process. Further, the cost of installing biometric scanners, both fingerprint and iris scanners, at each FPS, is higher in comparison to electronic swipe machines used in most non-biometric modes.[4]

Though the biometric mode ensures that the person drawing grains is exactly who they are entitled to, such levels of reliability can also be achieved using smart/barcoded cards, by adding additional layers of authentication security, such as a smart card PIN number and a one-time password sent via SMS. This will particularly address the concerns of senior citizens, who have a difficulty in commuting to provide their biometrics every month. In the non-biometric mode, their kith or kin can collect the grains and deliver them at their doorstep. Thus, contrary to the registration process, non-biometric mode seems more effective during the transaction process. Therefore, a possible way forward can be using smart cards as a mode of authentication at the time of transaction, and linking each smart card with beneficiary biometric data in the backend, during the registration process. In this way, states can leverage the superior deduplication abilities offered by the biometric mode, while ensuring that the risk of transaction failure and cost of implementation are not significantly high. This approach is being currently used by Tamil Nadu.

Source of authentication: The choice between local and central databases is primarily driven by the quality of internet connectivity. Using central databases requires robust web communication servers and strong internet/mobile connectivity in a region. This is particularly critical at the start of the month when the number of transactions are high. Therefore, using central databases may increase the instances of transaction failure due to internet connectivity issues, thereby leading to an increase in beneficiary dissatisfaction.[5] However, central databases provide an opportunity to continuously monitor FPS level grain inventory and quantity of grains claimed by each beneficiary. This allows states to offer the functionality of portability to their beneficiaries.

Through this functionality, beneficiaries can claim their entitlements from any FPS, in whatever quantities they please. Such functionality is expected to decrease quantity fraud and improve overall service quality of PDS, by introducing competition between FPS owners. Also, providing this functionality can ensure access to PDS entitlements to migrant workers and improve service quality at the FPSs as mentioned recently in a report from Chhattisgarh (Rajan et al 2016). Thus, both

options have different ways of decreasing beneficiary dissatisfaction. The ideal choice of a method depends on the strength of internet connectivity and the need for portability in a region.

Frequency of authentication: The aggregated frequency of authentication offers the states a faster and cheaper transition to using digital identities. This is because most states set up CSCs with uninterrupted supply of electricity and seamless internet connectivity, as a part of the National e-Governance Plan, launched in 2006 (OneWorld Foundation 2012). So, instead of computerising all the FPSs and upskilling every FPS owner, the states can piggyback on existing infrastructure and know-how at these e-governance centres. Gujarat was among the first states to have taken this route towards digitally authenticating PDS beneficiaries. Given that most e-governance centres have strong internet connectivity, we do not see states using aggregated frequency of authentication with local databases as a source of authentication, as observed in the methods B-LD-AG and NB-LD-AG in Table 1.

However, the aggregated frequency of authentication adds to instances of beneficiary dissatisfaction, as the beneficiaries will now have to make two trips—one to the e-governance centre for collecting coupons and another to the FPS, for collecting their grains. Grievances of long wait times and travel distances have been observed in Chhattisgarh and Odisha (Chatterjee 2014; Puri 2012). Further, instances of FPS owners forcing the beneficiaries to submit more coupons than required for a given quantity of grains, have also been reported (Choithani and Pritchard 2015). Such instances further increase the likelihood of beneficiary dissatisfaction. Thus, the choice between aggregated and real time frequency of authentication appears to be a trade-off between the resource constraints of the government and the service experience of beneficiaries.

Unlike the registration step where the biometric mode of authentication emerged as a superior method, there is no such clear winner for the transaction step. Instead, the choice of method appears to be dependent on five aspects: (i) the quality of biometrics, measured as a percentage of beneficiaries whose biometrics pass the UIDAI's fingerprint quality test, (ii) the quality of infrastructure, measured in terms of the frequency of interruptions to internet connectivity, (iii) prevailing resource constraints in terms of budget and time, (iv) proximity of the CSCs measured in terms of the average extra distance beneficiaries need to travel, if aggregated frequency of

Table 3: Efficacy of Different Methods in Curbing Observed Inefficiencies

Method for Registration	Method for Transaction	Ability to Reduce				Cost to Implement	Prerequisites
		Quantity Fraud	Identity Fraud	Beneficiary Dissatisfaction	Classification Errors		
B	NB–CD–RT	*Medium*, portability, a possibility	*High*, creation of fake biometrics and shadow usage of cards less likely	*Medium*, transaction failure due to poor connectivity	Cannot be addressed through digital identity	*Medium*, installing non-biometric ePoS readers cheaper.	Additional layers of security Robust internet connectivity Leverage Aadhaar-based biometrics
B	B–CD–RT			*Low*, transaction failure due to poor biometrics and connectivity		*High*, installing biometric readers expensive	Robust internet connectivity Good quality of biometrics Leverage Aadhaar-based biometrics
B	NB–LD–RT	*Low*, portability cannot be provided		*High*, transaction failures less likely		*Medium*, installing non-biometric ePoS readers cheaper	Additional layers of security Leverage Aadhaar-based biometrics
B	B–LD–RT			*Medium*, potential transaction failure due to poor biometrics		*High*, installing biometric readers more expensive	Additional layers of security Good quality of biometrics Leverage Aadhaar-based biometrics
B	NB–LD–AG	*Medium*, portability, a possibility	*Medium*, creation of fake biometrics less likely but shadow usage of coupon highly likely	*Low*, increase in beneficiary transaction time		*Low*, computerising e-governance centres cheaper than all FPSs	Additional layers of security Proximity of CSCs Leverage Aadhaar-based biometrics
B	B–CD–AG					*Low*, computerising e-governance centres cheaper than all FPSs	Availability of CSCs in the vicinity Good quality of biometrics Leverage Aadhaar-based biometrics
NB*	NB–CD–RT	*Medium*, portability, a possibility	*Low*, creation of inappropriate ration card entries highly likely	*Medium*, transaction failure due to poor connectivity		*Medium*, installing non-biometric ePoS readers cheaper	Periodic physical verification Additional layers of security Robust internet connectivity
NB	NB–LD–RT	*Low*, portability cannot be provided		*High*, transaction failures less likely		*Medium*, installing non-biometric ePoS readers cheaper	Periodic physical verification Additional layers of security
NB	NB–CD–AG	*Medium*, portability, a possibility		*Low*, increase in beneficiary transaction time		*Low*, computerising e-governance centres cheaper than all FPSs	Periodic physical verification Additional layers of security Proximity of CSCs

* If non-biometric mode authentication is chosen during the registration step, beneficiary biometrics cannot be used during the transaction step.
This table is generated by the authors with an objective of summarising their arguments in the article.

authentication was used, and (v) the prevailing criticality of each type of inefficiency. Table 3 (p 35) summarises the discussion on different combinations of methods for the registration and transaction steps.

Given that the assessment of these five aspects is expected to be different in different regions (villages/towns) of a state, governments may benefit from taking a customised approach specific to each region, as opposed to taking a one-size-fits-all approach. For instance, states with high resource constraints can consider using aggregated frequency of authentication in urban regions, which are expected to have a high density of CSCs. Whereas, a phased implementation of real time frequency can be considered in regions with a low density of CSCs, starting with areas where the robustness of internet connectivity is the highest. Such a customised approach to providing digital identities can prove more cost-effective and beneficiary friendly during the transaction process.

Conclusions and Future Scope

States are increasingly adopting Aadhaar-based biometrics for providing digital identities to PDS beneficiaries. However, this is not the only available method to provide digital identities. Several other methods exist and have been used by different states at different points in time. We identify, classify and evaluate these methods for their efficacy of addressing PDS inefficiencies in the registration and transaction processes. We find that despite other alternatives being available, the biometric mode of authentication seems to be more effective in the registration process. Consequently, the ongoing exercise of seeding Aadhaar numbers with ration cards is a promising step towards strengthening the states' RCMS. However, at the time of transaction, beneficiary biometrics need not be used. During this step, the ideal choice of method depends not only on the method's efficacy of addressing inefficiencies, but also on several other parameters such as the strength of internet connectivity, availability of e-governance centres and the prevailing resource constraints measured in terms of time/budget.

Therefore, governments can benefit from critically analysing their regional contexts before choosing their method. We provide the contexts in which each method works best for the governments to perform such assessments. However, more studies are needed to quantitatively assess the costs and benefits of each of the choices available. Examples of such studies include estimation of the value of the portability functionality offered by central databases and comparative cost–benefit analysis of biometric deduplication, in relation to deduplication using other approaches such as regular physical visits. Such studies can significantly help states such as West Bengal, Assam and Maharashtra, that are considering the use of digital identities in PDS, make an informed choice on the method best suited for their needs.

NOTES

1 This information was gathered during our field visits and interviews with Karnataka Food and Civil Supplies Corporation Limited officials.

2 Beneficiaries submit a duly filled and attested application form, along with one government identification and attested proof of income. The application form typically contains information such as name, age, occupation, financial status, address, number of family members and their individual details.

3 Ideally, such instances are supposed to be checked by mandate to produce a valid government identification proof. However, circulation of duplicate/fake government identification in India is common.

4 The calculation is based on the prices of biometric scanners and smart readers quoted by multiple sources. The price of a smart card reader was taken from Indiamart (2019a) and that for a biometric scanner set was obtained from Indiamart (2019).

5 The supply of electricity should also be considered in context. However, given that most of the ePoS devices and biometric scanners can be operated on solar/local battery power, we believe this issue can be easily resolved.

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