Food Security through Identity Management

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Abstract - The Targeted Public Distribution System (TPDS) in India is intended to provide food grains & essential commodities at subsidized prices to the poor. The presence of a large number of bogus and duplicate ration cards is resulting in this food subsidy scheme not reaching millions of poor eligible families. In addition, a huge number of ration cards[1] have been issued to non-poor ineligible families. In this paper, we highlight how this has been resolved by using Biometrics. This has ensured that the duplicate[2] / bogus[3] / ineligible[4] cards are weeded out resulting in "One Family – One Card".
Keywords – TPDS, UNWFP, Ration Card, Multi-Modal Biometrics, Unique ID

1. Introduction

The Targeted Public Distribution System (TPDS) in India is a mechanism for ensuring access and availability of food grains and other essential commodities at subsidized prices to the households. Under the TPDS, commodities like Rice, Wheat, Sugar, Kerosene etc. are distributed to citizens on a monthly basis through a network of Fair Price Shops (FPS) also known as Ration Shops. TPDS is the most far reaching in terms of coverage as well as public expenditure on subsidy. With a network of about 480,000 Fair Price Shops (FPS) across the country, TPDS is perhaps the largest distribution network of its type in the world.

2. Distribution System

TPDS is operated under the joint responsibility of the Central and the State Governments. The procurement of food grains is mainly done by the Central Government which are then stored in the Food Corporation of India (FCI) Godowns from where it is disbursed to the States & Union Territories. FCI issues food grains to the states based on allocations made by the Central Government. The State Governments undertake the operational responsibilities of identification of families below poverty line, issue of ration cards, allocation within the State, and distribution of commodities through the network of Ration Shops or Fair Price Shops. (FPS). The supply chain showing the movement of food grains from the farmers to the end consumers is shown in Figure 1.
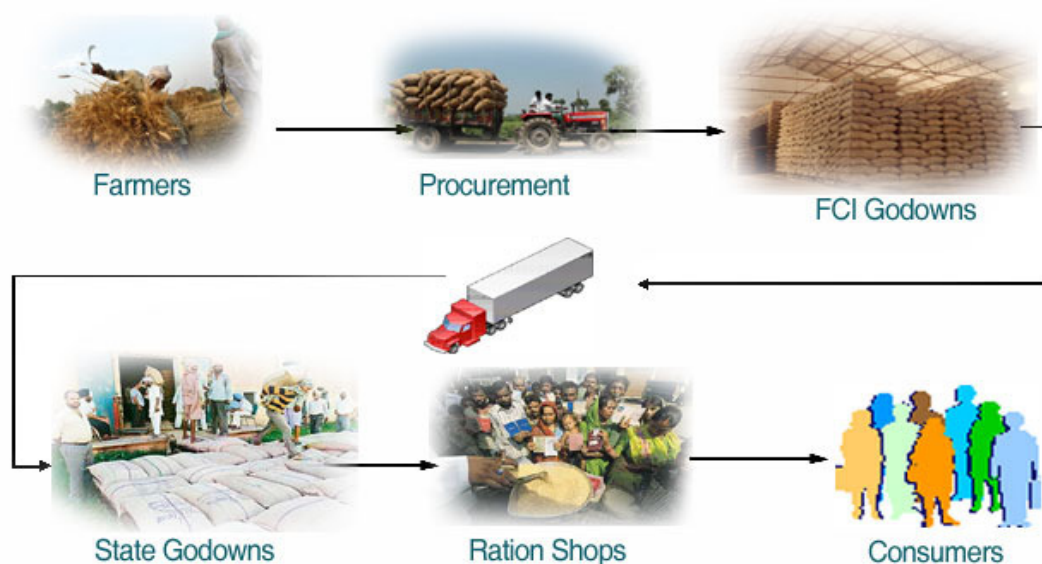

Figure. 1: Supply chain showing the movement of food grains from the farmers to the end consumers.

[1] This paper is written with specific reference to ration cards issued to people below the poverty line (BPL)
[2] Duplicate card indicates a household issued more than one card
[3] Bogus card indicates card issued in the name of a non-existent household
[4] Ineligible card indicates a Below Poverty Line card issued to an ineligible household.

3. Ration Cards

The State Governments undertake the responsibility to identify the eligible households/ beneficiaries and issue a ration card also known as household supply card which enables them to avail the prescribed quantity of food grains and/or other commodities. Households are categorized into two main categories - Below Poverty Line (BPL) and Above Poverty Line (APL). Defining BPL & APL families is based on the criteria like annual income, land holding, type of dwelling etc., which are decided by the Government from time to time. Out of the BPL families, the poorest of the poor to the extent of the target are selected for Antyodaya Anna Yojana (AAY) Scheme and Annapoorna scheme. For each of these categories, the states issue rations cards of different colors to the beneficiaries to easily differentiate between them.

4. Problem

Identification of eligible beneficiaries and ensuring delivery of food grains and other commodities to them effectively and efficiently is the basic challenge for TPDS. The objective here is to ensure that there are no errors of inclusion or exclusion during the selection of beneficiaries under various categories; BPL, APL etc. As per the data placed before Indian Parliament (2009), it is estimated that while there are about 23 million ghost[5] ration cards in the entire country, about 12.1 million deserving poor are left out of the TPDS. In Orissa alone, the estimated number of ghost ration cards is about 250,000. The Central and State Governments also incur a huge expenditure on food subsidy to meet the difference between the economic cost of food grains and the issue price fixed for TPDS. A study done by Planning Commission of India (2005) has indicated that about 58% of the subsidized food grain allocated by the Central Government to the States / Union Territories does not reach the BPL families because of identification errors and non transparent operations in the implementation of TPDS.

5. The Project

The United Nations World Food Programme (UNWFP) has undertaken a project on behalf of the Government of Orissa to address the problems associated with uniquely identifying a household. This project to strengthen TPDS was devised by UNWFP with the support of its' partner Boston Consulting Group (BCG). The project involves creation of a centralized database of eligible households, reissue of biometric based ration cards and institutionalizing new processes to better manage and monitor the distribution of food grains in Rayagada district of Orissa. UNWFP has entrusted the project to 4G Identity Solutions (4G) in view of its technological capabilities in biometric based identity management solutions and proven track record in delivering civil ID solutions. The scope of the project includes the following.

a. Digitization of the existing ration card issue registers and establishing data linkage between issue registers and household survey data to generate a complete list of all eligible BPL and APL households in Rayagada district. The final list to be maintained in both Oriya[6] and English.
b. Design and creation of a database to include the above digitized data.
c. Development of Enrolment application in dual language (Oriya & English) to collect biographic and multi-modal biometric (Iris, fingerprints & facial photograph) data and making a provision to collect any additional details in future.
d. Deployment of the enrolment application in a decentralized manner in the Enrollment Stations in the specified rural and urban blocks.
e. De-duplication of the citizen data to remove instances of multiple enrollments by the same person and creation of a Unique Citizen ID Database. This data will form the basis to generate all MIS reports.
f. Printing & delivery of ration cards for distribution to households after biometric validation of the beneficiaries.

6. 4G's Multi-Modal Biometric Identity Platform

4G provided the end-to-end technology solution for completing all activities envisaged in the project. Key to the successful implementation of the project is the deployment of 4G's Multi-Modal Biometric Identity Platform (Figure 2). 4G's Identity Platform is a robust, scalable, interoperable identification engine that interfaces and manages multi-biometric and biographic search technologies. 4G's platform provides an XML based interface to the custom-built application for identification and/or verification of a person's identity. The platform supports key features like Interoperability, Scalability, Extensibility, Flexibility and adherence to open standards.

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[5] "Ghost ration cards" include duplicate / bogus cards
[6] Oriya is the regional language spoken in the state of Orissa

Interoperability: 4G's Identity Platform is capable of integrating not only multiple biometric devices for enrollment but also search engine algorithms for de-duplication of iris, finger, face and biographic data.

Scalability: 4G's Identity Platform can easily scale up as the size of the deployment increases in terms of the number of people enrolled. 4G's web server architecture can seamlessly integrate with additional servers and can be configured to suit licensing policies from various biometric vendors.

Extensible: 4G's Identity Platform is extensible as it has been developed using a modular software design approach. Modules can be added in a plug-and-play manner and can be integrated to suit customer requirements. Components can be configured for centralized or de-centralized deployments.
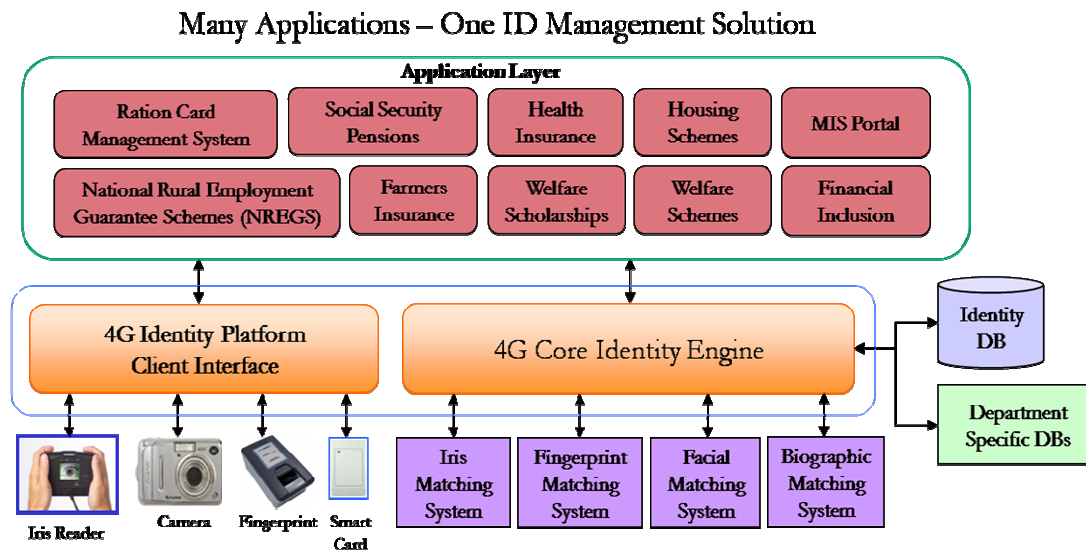
Figure 2. 4G's Multi-Modal Biometric Identity Platform

Flexibility: 4G's Identity Platform enables development of tailor made solutions to meet customer specific requirements. Various enterprise architectures and legacy systems can be integrated with 4G's web service architecture.

Open Standards: 4G's Identity Platform supports open standards that enable creation of biometric data which is compliant with International Biometric standards. i.e. CBEFF (Common Biometric Exchange File Format), NIST (National Institute of Standards and Technology), ANSI (American National Standards Institute), and ICAO (International Civil Aviation Organization).

7. 4G's Project approach

The project involved the following steps as shown in Figure 3.
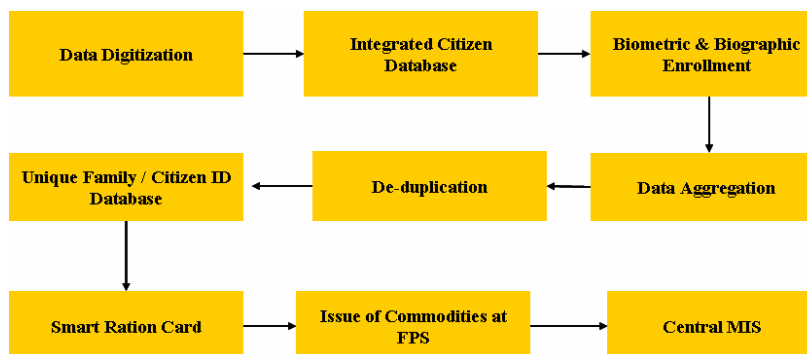
Figure. 3: 4Gs Project Approach

Step 1: The old ration card registers were digitized and mapped to the database of BPL survey done in 1997 along with the household survey data of 2002. The consolidated list of target beneficiaries was prepared.

Step 2: The gram panchayat[7] wise target beneficiary database was transferred to the enrolment stations located in the Enrollment Stations before commencement of the enrollment process. Wide publicity using posters, tom-tom and public announcement systems was given in the villages requesting them to visit the Enrollment Stations for the enrollment.

Step 3: Family wise enrollment of the target beneficiaries was undertaken by capturing the biometric data (4-4-2 slap fingerprints, 2- Iris and Facial Photograph). Since the Enrollment Stations are located in remote areas with no internet connectivity, enrollment was done in a decentralized manner using standalone systems.

Step 4: Periodical backups were taken from the Enrollment Stations and sent to 4G's data centre for data aggregation.

Step 5: The aggregated data from the Enrollment Stations was de-duplicated using 4Gs multi modal biometric engine to check for fraudulent enrolments. The identified duplicates were verified in the field to weed out duplicate beneficiaries.

Step 6: The final database of unique card holders was generated and stored in a centralized citizen database.

Step 7: The households in the rural areas will be given laminated ration cards along with bar coded coupons by incorporating security features to make them tamper proof and prevent replication. The laminated card will be presented by the cardholder to the FPS for verification and the coupons are surrendered for taking delivery of entitled commodities. The FPS dealer will surrender the coupons to the civil supplies department where they are scanned and destroyed. The data from the scanning device will be transmitted to the centralized server using internet connectivity.

Step 8: The households in the urban areas will be given smart cards containing details of the card holder and household members, their biometric templates and their entitlements. The smart card is swiped in the Point of Service (PoS) device and the transaction is authenticated by the biometric of the cardholder. The transaction data containing the card ID, quantities delivered to the card holder, time etc will be transmitted from the PoS device to the centralized server using GPRS connectivity.

Step 9: The data in the centralized server will enable the civil supplies department to get reports on the quantities of commodities delivered to the ration card holders and arrive at the closing balance of commodities at the FPS. The closing balance will enable the civil supplies department to derive at the allotment for the succeeding months. The data in central server can also be given access to public and other government departments with a view to enhance transparency and accountability.

8. Iris and Fingerprint Devices and Algorithms

Devices:

Iris images were captured using the PIER-T™ device from L-1 Identity Solutions. TPE-4100 fingerprint scanner from L-1 Identity Solutions was used to capture (4-4-2) four fingers on the right hand at one time followed by all four fingers on the left hand, followed by the two thumbs at the same time. The device had inbuilt real time feedback on the quality of the fingerprints being captured.

The touchprint photocapture digital system was used to capture the face of the citizen. The system also included the Identix FaceIt Face-Finding and Image Quality Assessment software reduces the potential for manual errors, so the operator no longer need to worry whether the image is centered, cropped or if the lighting is set properly. The photo capture component completely conformed to NIST best practices for high quality photo capture. Figure 4 shows photographs of the enrollment process using these devices.

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[7] A gram panchayat is a the administrative unit for a group of villages in a district

Figure. 4. Photographs of enrollment using the devices

Algorithms:

Daugman 07 (D07) Iris algorithm and SIRIS matching platform from L1 Identity solutions Inc, USA has been used for Iris enrolment & matching. The new L1 Daugman 07 (D07) algorithms utilize cutting edge image processing techniques such as active contours and off-axis gaze correction which vastly improves both Failure to Enroll (FTE) and False Rejection Rates (FRR).SIRIS and the new Daugman 07 (D07) algorithm introduce enhancements over the previous generation matching algorithms by utilizing advancements in computer technology such as 64 bit processor architecture and multi-core CPU technology. These improvements have brought about significant increases in speed and throughput capability. The efficient data storing and matching design allows commercial off-the-shelf hardware to produce matching speeds exceeding 1,000,000,000 comparisons per second.

For the fingerprints, the ABIS matching platform from L1 Identity solutions Inc. that incorporates the latest generation of Bio Engine fingerprint technology has been used. This system incorporates new and more accurate high-speed filters for fingerprint identification in increasingly large populations. ABIS System help to ensure that poor and unusable images are not admitted to the search database thus protecting optimum biometric performance.

9. De-duplication

During the de-duplication process, it is found that the same citizen gets enrolled more than once due to various reasons – some due to ignorance and some deliberate. An analysis of the duplicates found during the de-duplication process reveals the following types of duplicates as shown in Table 1. Figures 5 to 9 show samples of duplicates under each of the categories given in Table 1.

Table 1
Categories of Duplicates

Category	Description	Sub-Category
I	Matches with the same citizen ID in the same family	
II	Matches with different citizen-ID in same family	
III	Matches across different families within same village	• One person being head of more than one family.
IV	Matches across different villages in same block	• Both spouses heading separate families. • Family members other than spouse heading another family
V	Matches across different Blocks	• Both persons not heading the families

Figure. 5. Matches with the same citizen ID in the same family

Figure. 6. Matches with different Citizen-ID in same family

Figure. 7. Matches across different families within same village

Figure. 8: Matches across different villages in same block

Figure. 9: Matches across different Blocks

10. Issues in the finger print de-duplication process

The fingerprints of citizens are captured during the enrolment process using the 4-4-2 slap method. Some of the issues that crop up during the fingerprinting enrolment and pre-process for the de-duplication are given below.

1. During the de-duplication process, it is observed that there is a lot of "noise" or /and "hallowing" in the finger print images like shadow prints, ghost images etc. due to which False Acceptance Rate (FAR) and False Rejection Rate (FRR) are likely to be high. This is a typical phenomenon in the rural context where the fingers of the citizens are worn out due to their occupation which is mostly labor work. Lack of proper cleanliness of the fingers before enrolment also causes "noise" to creep in. Due to the "noise" in the fingerprint images, the fingers are wrongly identified during the segmentation process which precedes de-duplication. To overcome this problem, 4G has developed a "noise" removal solution using advanced image processing filters and techniques. Figure 10 shows the segmented finger print images before and after elimination of "noise".

| NFIQ Score | 0 | 4 | 4 | 5 | | NFIQ Score | 3 | 1 | 2 | 2 |
| No of Minutia | 11 | 98 | 107 | 54 | | No of Minutia | 12 | 25 | 13 | 24 |

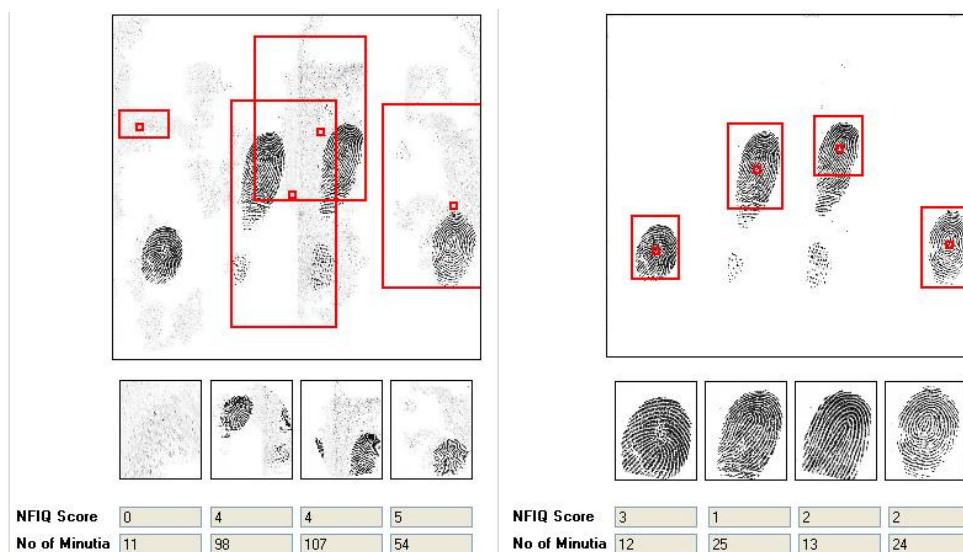**Figure. 10. Segmentation before noise removal & Segmentation after noise removal**

2. Other errors that could happen during the enrolment are cropped fingers, missing fingers, compressed fingers and overlapping fingers. This requires manual intervention in the system to assign the "right finger" to the "right place". Figure 11 shows the case of cropped fingers in the case of thumbs.
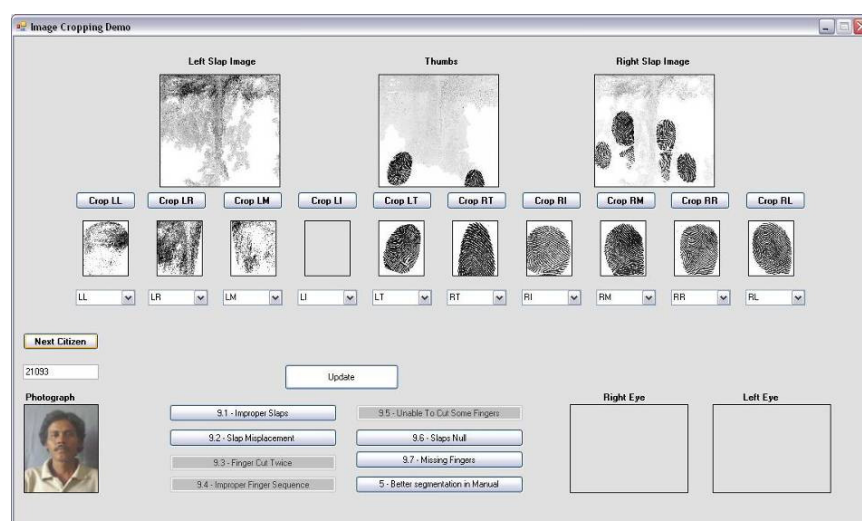

Figure 11: Cropped Thumbs

11. Implementation challenges and lessons learnt

- Successful enrolment is the key to the success of any biometric project.
- Multi-modal biometrics is preferred mode over a single biometric as each of them has their own advantages during enrollment, de-duplication, identification & verification. Moreover, enrolment of citizens is a major component of the total project cost and it is prudent to capture multi-modal biometrics of a citizen at one go instead of making them repeatedly visit the enrollment centers as and when a new biometric has to be captured.
- Support & involvement of key stakeholders is essential for successful implementation of the project.
- End user acceptance and training is critical to the successful deployment of projects of this size and nature.
- Logistics in rural and tribal areas with inadequate infrastructure and transportation facilities pose the greatest challenge. This would be a common phenomenon in most parts of the country where villages do not have proper access especially during the rainy season. Lack of electricity also poses a great challenge and generators need to be carried. Figure 12 shows some photographs of the situations that would be encountered during the enrollment.
- The integrated beneficiary database developed as a result of this process can be used to deliver other benefits to citizens.

Figure 12: Photographs showing the challenges faced due to lack of proper infrastructure in the villages

12. "One Citizen – One ID – Many Programs"

Governments today are implementing several welfare schemes such as PDS, Pension Schemes, National Rural Employment Guarantee Scheme (NREGS), Housing Welfare Scheme, Health Insurance scheme etc. for the most vulnerable and disadvantaged sections of society, with the objective of bringing about a qualitative change in their lives. These multiple initiatives are spread across several departments with each of them often duplicating the efforts of the others. It is essential that the Governments bring this plethora of welfare schemes onto a common platform. The ration card / household card information would be vital as this dataset is supposed to cover the entire population of the state. After de-duplication of the ration card data, a "Unique ID" for every citizen can be created that can be ported onto a "Central Identity Server". An Enterprise Architecture Framework adhering to the national e-Governance Standards has to be designed to integrate various departments to the Central Identity Server to authenticate the beneficiaries as and when required as part of disbursement of welfare benefits. By uniquely identifying a citizen, the Government will be able to target the right people with the right benefit, thus eliminating most of the maladies in the current welfare delivery system.

13. "Multipurpose Citizen ID"

As shown in Figure 13 , a citizen maybe eligible for various identity cards / benefits based on the Income and Age criteria. Based on the "Unique ID" database, Governments can issue a single card to a citizen and make him / her eligible for different purposes be it driving licenses, voter ID or for benefits like pension, housing, essential commodities etc. This multipurpose citizen ID card can also be designated as a "National ID" card which will be unique across the entire country.
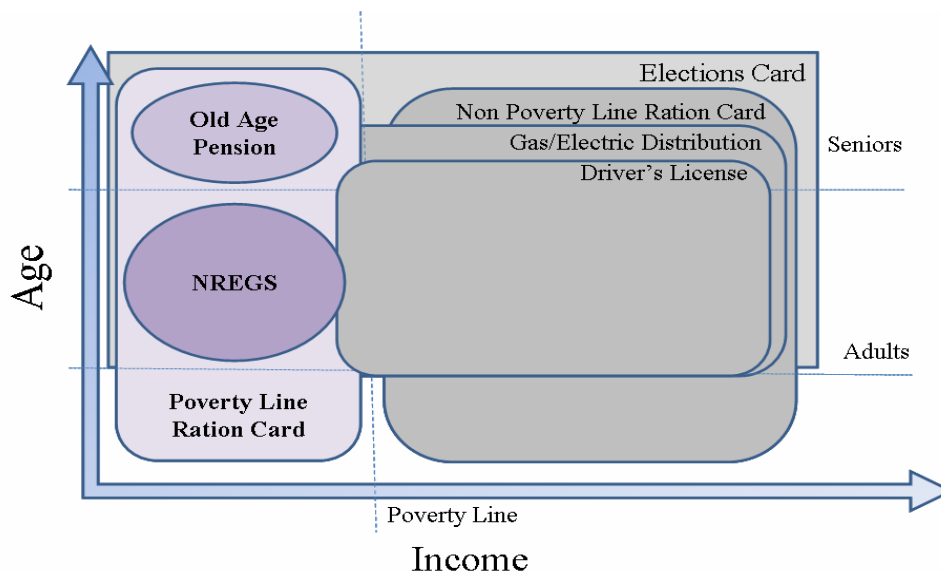

Figure 13: Multipurpose Citizen ID

14. Conclusion

A ration card in the Indian context has linkages to several schemes and Identity documents. A ration card is not only the basis for identifying beneficiaries under all the central and state government welfare schemes but is also a proof document for other citizen services like passport, Electoral Photo Identification Card (EPIC), driving licenses, land records, LPG connections, etc. **If Governments do not establish a unique identity for a citizen through ration card or other means of identification, there will be far reaching financial, social and security implications.**