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Empirical Study on Effective Outcome of Digitalisation of Public Distribution System in Tirunelveli District

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Abstract

The study examines the effective outcome of ***Digitalisation of Public Distribution System*** (PDS) to the beneficiaries in the study area. The study is conducted by interviewing a representative sample of Above Poverty Line (APL) and Below Poverty Line (BPL) cardholders in order to get an insight of the workings of the public distribution system as well as of the general public's perspective on how it functions. The core data are from the interviews conducted with residents of specific PDS beneficiaries in the Tirunelveli district. For the purpose of this research, data collection is from cardholders using proportional random sampling method. Z formula has given a sample size of 249 which is based on the outcome of reliability testing results. The approach of personal interview was conducted to gather feedback from the cardholders. In order to do an analysis of the data in relation to the goals of the research, the following techniques were used. The structural equation modeling approach was used for the evaluating productive results of PDS implementation of the digitalization process. The three factors of *Heightened Transparency in Operations, Leakage and Wastage Reduction and Eliminating Irregularities* have been the significant effects of digitalization and those factors ensure the effective working of PDS. This is done with the intention of shaping the perception of the public towards PDS operations by the state and it gives policy makers the opportunity to rebrand themselves as resourceful problem-solvers.

Keywords: Beneficiaries, Digitalization, Fair Price Shop, Outcome, Public Distribution System, Scarcity.

Introduction

Public Distribution System (PDS) in India has been around for over eight decades, ever since the British Government instituted rationing in Bombay in 1939 to ensure the fair distribution of food grains to urban consumers in the face of rising prices. During the interwar era in India, the government instituted regulations and created fair-priced shops for the purpose of distributing vital commodities. Along with these measures, quantity rationing of essential goods was also implemented during this

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time. This goes to illustrate that the subject of equitable distribution becomes more important when there is a scarcity of the goods as opposed to when there is abundance. When there is a sufficient supply of goods to satisfy the requirements of the population, there is minimal risk involved in entrusting the management of the supply chain to the private sector and letting the mechanisms of the market determine what constitutes a fair price for those goods. In fact, the primary reason for such an emphasis on increased production in the modern era is to ensure that individuals are able to purchase the items they want at costs that are within their financial means. Insufficient progress has been made in India on all of the necessary goods that are required by the average man.

When faced with a circumstance of this kind, we have no choice but to accord production and distribution the same level of significance and to give careful consideration to the many means by which we might improve the reliability and effectiveness of PDS. As part of the Targeted Public Distribution System (TPDS), the states are expected to devise and put into action foolproof procedures for the identification of the poor, for the transportation of food grains to fair price shops, and for its distribution in a transparent and responsible way at the Fair Price Shop (FPS) level. In addition, the states must account for the distribution of the food grains. According to the poverty estimates the Planning Commission has compiled for each state, the individual states determine who qualifies as being poor for the purposes of this program. The "Expert Group on Estimation of Proportion and Number of the Poor" developed the methodology on which these estimates are based. The distribution of food grains to the states and unorganized territories was determined based on the average consumption of food grains in the past, also known as the average yearly off-take of food grains under PDS during the course of the previous 10 years. Both the national government and individual state governments are jointly responsible for the PDS's day-to-day operations. The central government, which also serves as the purchaser, is responsible for paying the costs associated with acquiring stocks and supplying grain.

After the grain has been divided among the states, it is the responsibility of each state government to "lift" the grain and deliver it to the PDS retail locations placed across the states. As a result, the success of the PDS is contingent not only on the administration of food grains by the central government but also on the distribution of subsidized grain by the state governments. PDS is widely regarded as an essential instrument for maintaining price stability during the inflationary period. The economic condition known as inflation is characterized by a reduction in consumers' ability to buy products as a result of an increase in the general level of prices for those goods. This implies that a given sum of money can only be used to buy a limited number of items. It is generally agreed that inflation is an issue on several fronts, including the monetary, political, social, and structural levels.

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Because of this, there is an imbalance between the marked stock of fundamental products or basic commodities and the active stock of money in the economy. A situation of inflation exists not only because there is an imbalance between the stock of money and the stock of essential products but also because there is an increase in the disparity in economic levels between the various social classes, which places the poorest portion of the lower strata at a significant disadvantage.

The challenges faced by lower-income strata are made worse by inflation, which further skews the distribution process. Even a person living on a fixed income will experience significant hardship. The most severe disruptions to the distribution process are caused by chronic inflation. The theoretical model of economic equilibrium and the actual world continue to diverge farther and further apart. PDS is an anti-inflationary measure that has a significant effect on stabilizing prices. The price Stability of products and commodities is still one of the most essential goals of the Indian economy; otherwise, it would have a negative impact on both the consumer and the producer. If prices dropped, manufacturers would suffer a great deal and wouldn't be able to alter their cost of production to reflect the new market conditions. It has a devastating impact on the most impoverished people when it reaches its extremes, and the PDS may play a supportive role by controlling the prices of the commodities and protecting the most impoverished people's interests in this situation.

Now, in times of inflation, unemployment, food insecurity, climate change, and demonetization, PDS is an important instrument for addressing the tendency of price rises and to check and control issues related to inflation and demonetization by supplying commodities and food grains at reasonable or no cost to the weaker and more needy sections of society. This is done by supplying commodities and food grains to the weaker and needier sections of society. In a country like India, where around one-third of the population lives below the poverty line or below the level at which they can support themselves, a system like this has a vital role to play. The free supply of meals has the potential to save the lives of individuals with poor buying power and pull them back from the brink of famine and destitution. In the context of India, maintaining a constant and consistent flow of supply of vital items via a fair pricing store is, at the moment, both more complicated and difficult from the standpoint of the ordinary man. PDS is targeted at the wellbeing of individuals with poor buying power. A continuous flow of supply lines of basic products at fair prices in the context of India is all the more needed. Government performs the role of an ideal institution for a welfare state and guarantees the benefits of economic progress by distributing the rewards of production and productivity among all segments of society in a manner that is equitable.

The digitalization of the Public Distribution System (PDS) can be traced back to efforts aimed at leveraging technology to enhance the efficiency, transparency, and effectiveness of

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the system. The PDS is a government-sponsored program in many countries, including India, which aims to provide subsidized food and non-food items to eligible beneficiaries, typically those with lower incomes.

Origin of the digitalization of the PDS

The origin of the digitalization of the PDS can be attributed to the broader trend of using information technology to streamline and improve various government processes. Here are some key points in the evolution of the digitalization of the PDS:

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Automation and Computerization (Late 20th Century): The initial steps toward digitalization involved the automation and computerization of PDS operations. This included the use of computers for record-keeping, inventory management, and tracking the distribution of essential commodities.

Smart Cards and Biometrics (2000s): In the early 2000s, some countries, including India, started experimenting with smart cards and biometric technology to authenticate beneficiaries and ensure that subsidized goods reached the intended recipients. Smart cards,often linked to individual ration cards, were issued to beneficiaries, and biometric authentication methods, such as fingerprint or iris scanning, were implemented to verify identities during the distribution process.

Online Portals and Mobile Apps (2010s): As internet penetration increased, many countries began to develop online portals and mobile applications to facilitate PDS- related activities. Beneficiaries could use these platforms to access information about their entitlements, check stock availability at fair price shops, and register complaints. These digital platforms also helped in reducing manual errors and corruption.

Direct Benefit Transfer (DBT): The concept of Direct Benefit Transfer gained prominence as a means to transfer subsidies directly to the bank accounts of beneficiaries, cutting down on leakages and corruption. In the context of the PDS, this involved transferring the subsidy amount for food items directly to the bank accounts of eligible individuals, who could then purchase commodities at market prices.

Data Analytics and Monitoring (Recent Years): In more recent years, advancements in data analytics and monitoring technologies have been applied to PDS systems. This includes the use of data analytics to optimize supply chain management, monitor real-time stock levels, and identify patterns of misuse or fraud.

Overall, the digitalization of the Public Distribution System has been driven by the desire to improve efficiency, reduce leakages, enhance transparency, and ensure that subsidized benefits reach the intended beneficiaries more effectively. The specific strategies and technologies employed may vary from country to country based on their technological infrastructure, policy objectives, and socio-economic context.

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Need for digitalization of the Public Distribution System (PDS)

The digitalization of the Public Distribution System (PDS) holds significant importance

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due to the various benefits it brings to the administration, beneficiaries, and the overall efficiency of the distribution process. Here are some key reasons why the digitalization of the PDS is considered important:

Transparency and Accountability:

Digital systems enhance transparency in the distribution process by providing aclear record of transactions and stock levels.

Electronic tracking helps prevent pilferage, corruption, and other malpracticesthat may occur in manual, paper-based systems.

Efficient Supply Chain Management:

Digitalization enables real-time monitoring of stock levels, allowing authorities to manage and replenish supplies more efficiently.

Predictive analytics can be employed to forecast demand, optimize distributionroutes, and reduce wastage.

Targeted Beneficiary Identification:

Digital systems, especially those incorporating biometric authentication, help in accurately identifying and verifying beneficiaries.

This ensures that subsidies and benefits reach the intended recipients, preventing diversion or misuse.

Reduction of Leakages and Corruption:

Direct Benefit Transfer (DBT) through digital platforms ensures that subsidies are directly credited to the bank accounts of beneficiaries, reducing leakages and corruption in the system.

Electronic records make it easier to audit and track financial transactions, making it more challenging for fraudulent activities to go unnoticed.

Improved Access to Information:

Online portals and mobile apps provide beneficiaries with easy access to information about their entitlements, stock availability, and distribution schedules.

Increased accessibility enhances the empowerment of beneficiaries by giving them more control over their entitlements.

Cost Efficiency:

Automation of processes through digital systems can lead to cost savings in terms of reduced paperwork, manual labor, and the overall operational expenses of managing a large-

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scale distribution system.

Timely and Accurate Reporting:

Digital platforms facilitate the generation of accurate and timely reports, aiding decision-makers in understanding the performance of the PDS.

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Data analytics can be applied to identify trends, assess the impact of policies, and make informed adjustments to the distribution system.

Adaptation to Changing Technologies:

Embracing digitalization allows PDS to stay relevant and adaptable to evolving technologies.

It provides a foundation for the integration of emerging technologies such as Internet of Things (IoT), block chain, and artificial intelligence for further improvements.

Enhanced Customer Service:

Digital platforms enable smoother communication between beneficiaries and the authorities, allowing for faster resolution of issues, complaint handling, and feedback mechanisms.

In summary, the digitalization of the Public Distribution System is crucial for improving efficiency, reducing inefficiencies, ensuring the fair distribution of subsidies, and enhancing overall governance in the delivery of essential commodities to the economically vulnerable sections of the population.

Challenges of the Public Distribution System

While the digitalization of the Public Distribution System (PDS) brings several benefits, it has also faced criticism and challenges. Some common criticisms include:

Digital Divide:

One of the primary criticisms is the existence of a digital divide, where certain sections of the population may lack access to the necessary technology. This includes issues related to internet connectivity, smart phones, and digital literacy.

In rural and remote areas, where access to technology may be limited, beneficiaries may face challenges in using digital platforms for accessing their entitlements.

Exclusion of Vulnerable Populations:

Biometric authentication methods, such as fingerprints or iris scans, can sometimes lead to exclusion, particularly for individuals with worn-out fingerprints or those with physical disabilities.

This exclusionary aspect can disproportionately affect vulnerable populations who may find it difficult to undergo the biometric authentication process.

Technical Glitches and Downtime:

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Technical glitches, system failures, and downtime can disrupt the distribution process. This can lead to delays in accessing essential commodities and create frustration among beneficiaries.

Dependence on technology makes the system vulnerable to disruptions, and it requires robust infrastructure and backup systems to ensure continuity.

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Privacy Concerns:

The collection and storage of biometric data raise privacy concerns. There is often a lack of clarity on how the collected data is used, stored, and protected from unauthorized access.

In some cases, there have been concerns about the misuse of personal data for purposes beyond the scope of the PDS.

Resistance to Change:

Resistance to adopting digital methods may come from both administrators and beneficiaries who are accustomed to traditional paper-based systems.

Lack of awareness, understanding, or trust in digital systems can hinder the successful implementation of digital initiatives.

Complexity and User Interface Issues:

Digital platforms may be complex for some users, especially those who are not familiar with technology. Complicated user interfaces can lead to confusion and errors.

The elderly or those with limited digital literacy may find it challenging to navigate online portals and mobile applications.

Corruption in the Digital Space:

While digitalization aims to reduce corruption, it doesn't eliminate the possibility entirely. Issues such as fraudulent transactions, data manipulation, or collusion can still occur in the digital realm.

Overemphasis on Technology:

Sometimes, there may be an overemphasis on technology without addressing the underlying issues in the distribution system. Digitalization alone may not solve problems related to corruption, inefficiency, or inadequate infrastructure.

Lack of Consultation with Stakeholders:

Implementation of digital systems without proper consultation with all stakeholders, including beneficiaries and local communities, can lead to dissatisfaction and resistance.

It's important to note that the success of the future PDS in India will depend on the adaptability of the system to changing circumstances, inclusivity in policy design, and the ability to leverage technology for the benefit of the vulnerable sections of the population. The involvement of multiple stakeholders, including government agencies, private enterprises, and local communities, will play a crucial role in shaping the future trajectory of the Public Distribution System in India.

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Future of the Public Distribution System (PDS)

The future of the Public Distribution System (PDS) in India is likely to be shaped by a combination of technological advancements, policy reforms, and a continued focus

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on improving the efficiency and effectiveness of the system. Here are some potentialtrends and developments that could influence the future of PDS in India:

Technology Integration:

Increased integration of emerging technologies such as Internet of Things (IoT), block chain, and artificial intelligence could further enhance the efficiency, transparency, and security of the PDS.

Advanced data analytics may be employed for better demand forecasting, supplychain optimization, and monitoring of distribution patterns.

Biometric Authentication and Digital Identity:

Biometric authentication methods may continue to evolve, addressing concerns related to exclusion and privacy.

The use of digital identity solutions could streamline beneficiary identification and help in preventing duplication and fraud.

Expansion of Direct Benefit Transfer (DBT):

The trend of direct transfer of subsidies to bank accounts of beneficiaries is likely to continue, reducing leakages and corruption.

The DBT model can be expanded to cover a broader range of subsidies, including those beyond food items, creating a more comprehensive and efficient welfare deliverysystem.

Focus on Nutritional Security:

There might be a shift in focus from mere food distribution to ensuring nutritional security. This could involve diversification of the PDS to include a variety of nutritious food items, addressing the issue of malnutrition.

Incorporation of Sustainable Practices:

Efforts may be made to make the PDS more environmentally sustainable. This could involve exploring eco-friendly packaging, reducing food wastage, and adopting sustainable supply chain practices.

Enhanced Monitoring and Evaluation:

Continued emphasis on monitoring and evaluation through real-time data tracking and analysis to identify bottlenecks, improve efficiency, and assess the impact of PDS policies.

Integration of feedback mechanisms for beneficiaries to provide insights into the functioning of the system

Customization and Local Adaptation:

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Recognizing the diverse socio-economic conditions across different regions of India, there may be a push for more localized and customized approaches to PDS implementation.

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States may have greater flexibility to tailor PDS policies to suit their specific needs and challenges.

Public-Private Partnerships (PPPs):

Increased collaboration between the government and private sector entities to leverage their expertise and resources for optimizing PDS operation. Integration of technology solutions is developed by the private sector to enhance the digital infrastructure of the PD.

Social Innovation and Community Participation:

Encouragement of social innovation and community participation to address last-miledelivery challenges.

Community-based models and partnerships with local self-help groups and NGOs to improve the reach and impact of the PDS

Policy Reforms:

Continuous policy reforms aimed at addressing existing challenges and adapting the PDS to evolving socio-economic dynamics.

The exploration of innovative policy measures to enhance the overall effectiveness of the distribution system.

It's important to note that the success of the future PDS in India will depend on the adaptability of the system to changing circumstances, inclusivity in policy design, and the ability to leverage technology for the benefit of the vulnerable sections of the population. The involvement of multiple stakeholders, including government agencies, private enterprises, and local communities, will play a crucial role in shaping the future trajectory of the Public Distribution System in India.

Review of Literature

Masiero, S. (2017)[1]

The study focuses on the ways in which architectures that are used in anti-poverty programs regulate citizens' ways of' seeing the state' for those who are living in

[1] Masiero, S. (2017). Digital governance and the reconstruction of the Indian anti-poverty system. *Oxford Development Studies*, *45*(4), 393-408.

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poverty. This system is enhancing India's primary food security program by adding computerized user identification. Biometric technology is portrayed as the best possible answer to the problem of illegally selling PDS commodities on the market. Nevertheless, according to the many accounts gathered from various parts of the state, beneficiaries disagree with this notion in a variety of different ways due to the contradictory implications that the evolving technology has had on their rights under the PDS. It has been discovered that citizens' impressions, which are formed as a result of their interactions with the new technology of governance, act as a constraint on the capacity of the government to rebuild its image via the use of digital innovation.

Maiti, D., Castellacci, F., & Melchior, A. (2019)[2]

Emerging economies face both new opportunities and new challenges as a result of advances in information and communication technologies (ICTs). The broad use of ICT has the potential to boost productivity and efficiency, give rise to novel services and occupations, and strengthen ties between various actors. However, a variety of other social, economic, and institutional variables determine how much these advantages are really realized by developing economies. Along with the more expected outcomes of digitalization, such as higher economic growth and productivity, digital gaps and accompanying forms of exclusion and injustices are often experienced. India, one of the world's largest economies, is seeing a tremendous pace of ICT diffusion; therefore it may serve as a useful case study for examining the impact of digitalization on economic development. This book collects a wide range of new writings on the subject, looking at the Indian experience through the lens of global comparison. This study provides background on the situation in India and lays out the general principles behind the interplay between information and communication technologies (ICTs), economic growth, and digital divides.

Joshi, A., Sinha, D., & Patnaik, B. (2016)[3]

When looking at the reforms undertaken by the Government of Chhattisgarh, notably the Centralized Online Real-time Electronic Public Distribution System (CORE PDS), it is discovered that although previous changes were effective, the contribution of CORE PDS has been valuable but limited. The problems of power disparities between

[2] Maiti, D., Castellacci, F., & Melchior, A. (2019). Introduction: Digitalisation and Development: Issues for India and Beyond. *Digitalisation and Development: Issues for India and Beyond*.

[3] Joshi, A., Sinha, D., & Patnaik, B. (2016). Credibility and portability? Lessons from CORE PDS reforms in Chhattisgarh. *Economic and Political Weekly*, 51-59.

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shop owners and cardholders are still impacting their relationships notwithstanding the CORE PDS advances. There was nothing that reforms advocating transparency, accountability, and a freer market could have accomplished here.

Chaudhuri, B. (2021)[4]

The research aimed to understand how digital identity technologies affect the relationship between the government and its people. Through the lens of' seeing the state' and the methodology of 'anthropology of state,' this study explored the fluidity of the state's relationship with its citizens by examining the material and social practices surrounding Aadhaar, India's central digital ID system. The study suggested that people's views of the state shift after becoming familiar with the inner workings of Aadhaar, based on data from ethnographic research on benefit distribution in Jharkhand. This research proved that a basic digital id system mediates shifts in the exploring practices that shape how a state is seen by its citizens.

Carswell, G., & De Neve, G. (2022)[5]

Based on qualitative data from rural Tamil Nadu, this article examines how recipients of the Public Distribution System (PDS) feel about the impact of technology on transparency, exclusion, and mediation. 'Smartcards,' new digital and Aadhaar-enabled ration cards, were deployed at ration outlets across Tamil Nadu in 2017. The writers analyzed how it was put into practice. They start off by explaining how digital smartcards and SMS create another layer of opacity and knowledge gaps for receivers. They then demonstrate how, despite the automation of the PDS, issues with exclusion still exist due to a lack of disclosure. Finally, the study highlighted the distinct types of kin and non-family mediation and their importance in reducing barriers to access PDS and other kinds of social assistance.

Masiero, S. (2020)[6]

Nine years of research on Aadhaar's digital and biometric architecture and its significance in the reform of India's Public Distribution System (PDS) are condensed in this article. This research examined the effects of biometric identification at ration outlets in two states (Kerala and Karnataka) to demonstrate how the transition to an Aadhaar-

[4] Chaudhuri, B. (2021). Distant, opaque and seamful: seeing the state through the workings of Aadhaar in India. *Information Technology for Development*, *27*(1), 37-49.

[5] Carswell, G., & De Neve, G. (2022). Transparency, exclusion and mediation: how digital and biometric technologies are transforming social protection in Tamil Nadu, India. *Oxford Development Studies*, *50*(2), 126-141.

[6] Masiero, S. (2020). Biometric infrastructures and the Indian public distribution system. *South Asia Multidisciplinary Academic Journal*, (23).

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based PDS has altered program management and beneficiary rights. The paper argued that a biometric PDS, although designed to combat the rice mafia's role in foodgrain diversion, instead speeds up the adoption of a cash distribution system whose developmental consequences are unclear and caused widespread exclusion errors. This research added to the ongoing conversation on coded citizenship in South Asia by investigating the influence of biometric infrastructures on food security programs and the ways in which a digital PDS may be adjusted to include underserved populations.

Ganesh, M., Deo, S., & Devalkar, S. K. (2019)[7]

The research found that BA devices may reduce current last-mile diversion by up to 4% by restricting grain delivery to confirmed receivers. The study supplemented the empirical investigation with a full simulation exercise. Sales and stock data collected by BA devices were analysed and was concluded that better replenishment planning may provide significant benefits. The gains from improved planning might be four times as large as those from reduced diversion rates.

Kumar, G. K. (2017)[8]

The eradication of global hunger by 2030 is one of the most significant Sustainable Development Goals (SDGs), and ensuring a steady supply of food is essential to this goal's success. Following India's independence, the government made a concerted effort to ensure that the poor and hungry had access to food via the Public Distribution System (PDS). Corruption, leaks, ghost cards, rations diversion to the black market, and other supply chain management problems all pose challenges to the PDS's implementation. In order to analyze how ICT is being used to fight corruption and 'leakages,' this research looked at India's Public Distribution System (PDS) program to alleviate famine. Because of India's federal system, several states are in charge of implementing the PDS; the NFSA promotes the use of available ICT resources by these governments. Differences in IT governance frameworks may account for variations in state food policy implementation.

Masiero, S., & Arvidsson, V. (2021)[9]

[7] Ganesh, M., Deo, S., & Devalkar, S. K. (2019). Leveraging digital technology to improve monitoring and planning in public sector supply chains: Evidence from india's food security program. *Indian School of Business*.

[8] Kumar, G. K. (2017). Implementing Food Security and e-Governance Initiatives: A Comparative Studyof Chhattisgarh and Telangana. *Public Affairs and Governance*, 5(2), 220-245

[9] Masiero, S., & Arvidsson, V. (2021). Degenerative outcomes of digital identity platforms for development. *Information Systems Journal*, *31*(6), 903-928.

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Virtually everyone acknowledges that digital identity systems are critical for strengthening social support networks. However, these channels have been linked to the emergence of a wide range of unintended consequences for those who benefit from development aid. By assessing the enactment of Aadhaar, the largest electronic identification structure in the world, in the country's primary nutritional security scheme, insight was provided on how electronic identity sites enabled the creation of a particular outcome .The study believed that Aadhaar contributed to the degenerative outcome by enabling financial transfers to replace the public's distribution of subsidized foodstuffs via marginalization, distortion, and misdirection.

Jaspars, S., & Sathyamala, C. (2021)[10]

In recent years, "digital welfare states" have emerged to provide citizens with more convenient access to basic necessities like food and healthcare. Since 2010, India's PDS (Public Distribution System) has undergone a complete digital transformation. As of 2016, digital welfare administration in the United Kingdom would be the norm, with asylum seekers receiving help via biometrics and debit cards. As a precaution against the spread of the Covid virus, all three countries have rushed toward complete digitization. In this study, it was claimed that digitization has not addressed the problem of hunger and was instead likely to make already-marginalized groups even more so.

Research Gap

The emphasis of the study has shifted in recent years due to the increasing significance of digital technologies in the public sector. In the beginning, it was anticipated that governments would play a prominent role in the provision of services via e-governance initiatives of all shades; however, this was to be done in conjunction with private sector and non-profit companies. These new opaqueness's have an effect on the procedures that are used to exclude people and the mediation that is used to determine who gets access to assistance. In point of fact, resolving inclusion mistakes is a second significant driver for the use of biometric technology in the delivery of PDS. Researchers and legislators alike have the goal of increasing access to social assistance while simultaneously filtering out those who are not qualified for the help.

[10] Jaspars, S., & Sathyamala, C. (2021). *Digital bodies and digitalised welfare: North-South linkages in the politics of food assistance and social welfare* (No. 687).

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The evidence that has been gathered up to this point has been fairly mixed, but the consistent denial of benefits while having legal rights is a significant obstacle to the execution of policy. Despite the fact that the biometric PDS is designed to reduce the likelihood of making an error of inclusion, there is no mechanism in place to avoid the opposite problem—namely, the exclusion of those who have a claim that is legitimate. Unanticipated types of exclusion also continue to hinder developments in biometric technology and digital technology. Failures in biometric authentication, for example, provide a typical barrier to entry. This is only one of the many factors that are connected to the technology itself. The advantages of decreased corruption were found to be matched by growing exclusion rates due to failed Aadhaar connection and verification procedures, according to a recent study on the usage of biometric identity. The earlier studies highlighted the need for more in-depth study about how to quantify the positive effects of PDS digitization.

Statement of the Problem

The post-targeting dynamics may be responsible for a significant portion of the nationwide issue known as leakage. Transactions on the black market are responsible for the loss of a significant quantity of items that occur between the FCI and private manufacturers and the ration shops. Because rice is the most important commodity in the PDS, this problem has been given the nickname "rice mafia," and the major object of criticism is the fact that it continues to exist. However, the leakage issue has compelled changes at the state level, and these adjustments have been beneficial in reducing the amount of instances in which these mistakes have occurred in a number of circumstances. The government believes that the rice mafia is responsible for practically all of the theft that occurs inside the system. In spite of the fact that storage and transportation losses are regularly identified, it is believed that linkages to the black market are to blame for the leakage. On the black market, BPL rice is sold at rates that are far higher than those found inside the PDS. This causes the system to become dysfunctional, making it more challenging for the poor to get the food for which they are legally entitled.

The most important issue is, "Which individuals are really involved in the rice mafia?" due to the fact that extensive supply networks make it difficult to precisely ascribe blame for the diversion. It would seem that the government is of the opinion that

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operators of ration shops are to blame when they refuse service to customers by claiming they are out of stock of a certain item. A transition to cash transfers raises a number of practical difficulties, the most important of which are the potential for the poor to be excluded, a lack of protection against price inflation, and the inexperience of vulnerable groups in dealing with financial institutions. Concerns over the undesired participation of the market in a system that was previously separated from it need to be linked to sociopolitical understandings of the change that is being proposed.

In India, users of the Public Distribution System (PDS) strongly prefer the current PDS with diverse forms of digitalization. Interviews with PDS beneficiaries based on the digitalization revealed the policy reason for this move. The efficiency with which PDS digitalizes the aforementioned issues calls for an evaluation of the cost's justification.

Research Question

- What are the diverse effective outcomes of digitalization of PDS in the study area of Tirunelveli?

Significance of the Study

PDS is a three-part supply chain that helps to feed India's underprivileged by providing staples including rice, wheat, sugar, and kerosene at reduced prices. First, from their own warehouses, Authorized Wholesale Dealers (AWDs) ship FCI and privately manufactured goods to individual districts. Following this, proprietors of fair-price shops buy products from the regional AWD and re-distribute them to scheme participants on a regular basis. To cap it all off, the subsidized goods are bought by the beneficiaries from fair-price stores, sometimes known as 'ration shops' owing to the monthly quota system under which commodities are given. To assist low-income households afford food that meets their nutritional needs, the PDS charges less than the market price.

The government uses technology for a variety of purposes, such as ration shop audits and the distribution of goods. TSOs may distribute PDS supplies fairly by employing a computer algorithm to assess the need of each ration dealer in their zone. This means that every business should have enough goods to last the whole month for every customer. The second system is the Inspection Monitoring System, which maintains a record of inspectors' visits to ration stores to root out the black market for PDS supplies.

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The policy justification for this change was disclosed via a series of interviews with government officials and NIC software developers. The records of certain ration dealers are padded with false cards whose numbers do not exist in the system. This is done in order to make the records seem more complete. They could report sales to nonexistent customers in order to fool the inspectors who check the registers and hide the fact that they are making illicit sales to the black market. This would give the impression that their business is legitimate. It is required that every purchase be accompanied by a valid Aadhaar number. This is made possible using biometric identification, which links each user to the biometric information that is unique to them. These points to a two-pronged system of oversight, with ration dealers barred from selling to non-eligible customers and genuine receivers collecting all payments. The study's primary objective is to determine whether or not digitization can successfully remove the effects of middlemen.

Objective of the Study

- To evaluate the effective outcome based on the digitalization of PDS to beneficiaries in the study area.

Research Methodology

To begin, a study is conducted by interviewing a representative sample of APL and BPL cardholders in order to get insight of the workings of the public distribution system as well as the general public's perspective on how it functions. After that, an IT-enabled system that uses back end database management and a smart card-based system of distribution of various essential commodities from fair price shops was designed as a process diagram. This diagram was then taken to various experts in the fields of information technology and public distribution system in order to seek their valuable opinion for the proposed system and explore an opportunity to improve the system. The core data are from interviews conducted with residents of specific houses in the Tirunelveli district. For the purpose of this research, data collection from cardholders is being done through proportional random sampling. Z formula has given a sample size of 249 based on the outcome of reliability testing results. The approach of conducting personal interviews was selected as the way for gathering feedback from cardholders. In order to conduct an analysis of the data in relation to the goals that were decided upon for the research, the following techniques were used. The structural

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equation modeling approach was used for the purpose of analyzing the results of the PDS implementation of the digitalization process.

Analysis and Interpretations

The model helps to examine the gap between the communication made by the marketer and how it reaches the beneficiaries based on digitalisation. The digitalization effects were reduced to factors based on the analysis and it helps to bring out the effects created by digitalisation. The coding of the variables and factors is given below

I.	***Heightened Transparency in Operations***	-	***HTO***
a.	Detailed purchase history of food grains	-	HTO1
b.	SMS alerts for purchases	-	HTO2
c.	Stock availability in PDS	-	HTO3
d.	Detailed Timing of Operations	-	HTO4
e.	Information on Distribution	-	HTO5
II.	***Leakage and Wastage Reduction***	-	***LWR***
a.	Arrest of food grains leakages	-	LWR1
b.	Accountability is ensured	-	LWR2
c.	Reduction in wastages	-	LWR3
d.	Proper Measurement in Distribution	-	LWR4
III.	***Eliminating Irregularities***	-	*EI*
a.	Bogus Cards are eliminated	-	EI1
b.	Proper documentation is done	-	EI2
c.	Higher responsibility is ensured	-	EI3
d.	Hindrance of local authorities are eliminated	-	EI4

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Structural Equation Modelling

The components that are having beneficial outcomes of digitalization of PDS are analyzed based on the factors that have been discussed above, which are then utilized for the creation of a route model based on structural equation modeling.

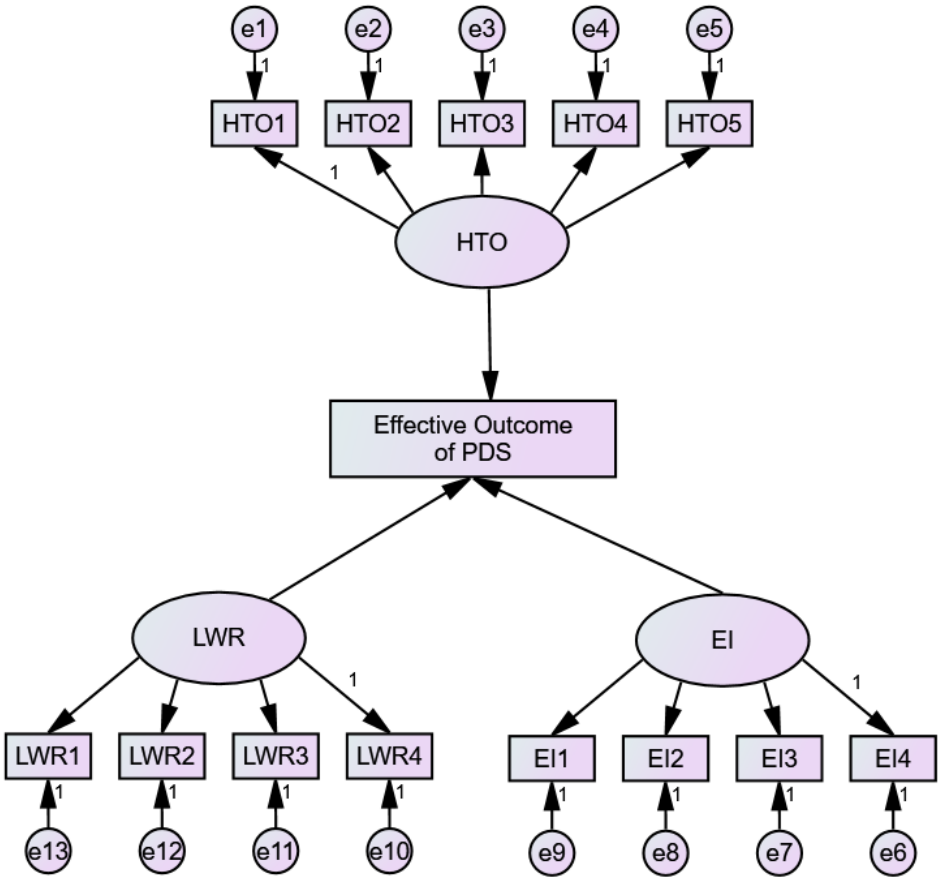

Figure -1

Tested Model - Effective Outcome of Digitalization of Public Distribution System

The model that detects the gaps in the perceptions of the recipients is assessed based on the above model. On the basis of these factors, the modeling will provide a substantial analysis of the cause and impact of the digitization of PDS. The study's beneficiaries are people who are already very knowledgeable about the process and the conclusion, and their participation in the research will make it easier to comprehend what the effects of digitalization will be based on the model's predictions.

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Table-1 – Number of Variables

S. No	Information	Counts
1.	Number of Variables in the Model	30
2.	Number of Exogenous Variables	14
3.	Number of Endogenous Variables	16
Sample Size		249

(Source: Primary Data)

Maximum Likelihood Model

The maximum likelihood technique provides an explanation of the link between the components and variables that make up the brand gap via the use of regression weights. There is a considerable association between the many factors that are a part of the research that tries to assess the impact of digitalizing PDS, and this relationship is significant. The conclusion of the effect analysis is derived from the findings of the investigation, which are then weighted using regression.

Table -2

Likelihood Estimates

			Estimate	S.E.	C.R.	P	Label
HTO	<---	HTO	1.000				
HTO	<---	HTO	0.688	.080	8.625	***	
HTO	<---	HTO	0.877	.101	8.697	***	
HTO	<---	HTO	0.864	.080	10.740	***	
HTO	<---	HTO	0.964	.096	10.079	***	
EI	<---	EI	1.000				
EI	<---	EI	0.677	.084	8.070	***	
EI	<---	EI	0.922	.101	9.089	***	
EI	<---	EI	0.931	.094	9.954	***	
LWR	<---	LWR	1.000				
LWR	<---	LWR	0.943	.124	7.598	***	
LWR	<---	LWR	1.177	.152	7.752	***	
LWR	<---	LWR	1.064	.134	7.967	***	

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			Estimate	S.E.	C.R.	P	Label
Digitalisation of PDS	<---	HTO	1.588	.119	-13.350	***	
Digitalisation of PDS	<---	LWR	.340	.090	3.800	***	
Digitalisation of PDS	<---	EI	1.558	.128	12.216	***	

*(***- indicates significance @ 1 % level and **- indicates significance @ 5 % level)*

The above table reveals that all the three factors identified in the study have significant effective outcome based on the digitalization of PDS. The most important factor that is having vital impact is Heightened Transparency in Operations and Leakage and Wastage reduction which has significant outcome attained based on the opinions of beneficiaries. The digitlisation of PDS is significant concept which helps to determine effectiveness in distribution of food-grains resulting in arrest of leakages and this model will help to evaluate it quantitatively which forms the uniqueness of the study.

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Path Model

The following model is fit based on the parameters that evaluates the path model and this framed model analyses the effective outcome of digitalization of PDS in the study area

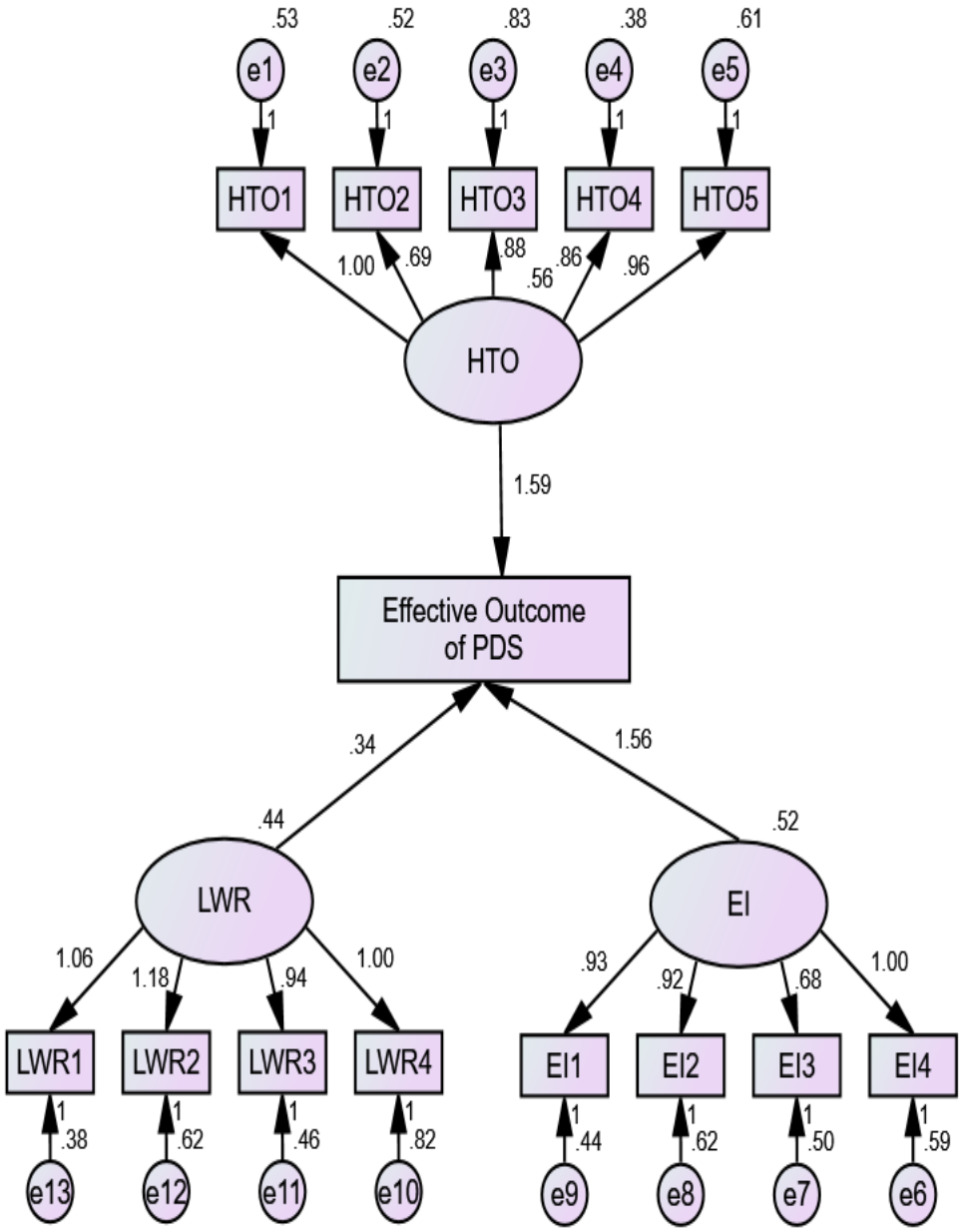

Figure -2

Fitted Model - Effective Outcome of Digitalization of Public Distribution System

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Table - 3

Goodness of Fit Indices

Indices					
Chi-Square (CMIN)	**Actual Value**	**Suggested Value**	***Goodness of Fit (GFI)***	**Actual Value**	**Suggested Value**
	3.945	< 5.00 (Hair et al., 1998)		***0.912***	> 0.80 (Joreskog and Sorbom, 1981)
Adjusted Goodness of Fit (AGFI)	**ActualValue**	**Suggested Value**	***Normed Fit Index (NFI)***	**Actual Value**	**Suggested Value**
	0.867	> 0.80 (Joreskog and Sorbom, 1981)		***0.846***	> 0.80 (Joreskog and Sorbom, 1981)
Comparative Fit Index(CFI)	**Actual Value**	**Suggested Value**	***Root Mean Squared Residual (RMR)***	**Actual Value**	**Suggested Value**
	0.893	> 0.90 (Daire et al., 2008)		***0.054***	< 0.08 (Hair et al. 2006)
Standardised Root Mean Squared Residual (RMSEA)	**Actual Value**	**Suggested Value**			
	0.078	< 0.09 (Hair et al. 2006)			

The model assessed reveals that the digitalization of PDS is having significant effect on the effective working of Fair Price Shops. The three factors of *Heightened Transparency in Operations, Leakage and Wastage Reduction and Eliminating Irregularities* have significant effects of digitalization and those factors ensure the

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effective working of PDS. The effective outcome of PDS is dependent on these factors which are vital for efficient distribution of food-grains to the beneficiaries.

Discussion

The study examined the impact of digital architectures' inclusion in an anti-poverty program to determine their efficacy of digitization of PDS in Tamil Nadu. On the one hand, reports from the field showed that the government is putting in place the biometric infrastructure of Aadhaar as the best way to stop leakage or diversion from the PDS. But many individuals think this portrayal is inaccurate because they see technology as being overly skewed towards the ration vendors. They think it's an incorrect depiction. Since perception is structured through encounters between a state and its citizens, biometric recognition is used for reassembling precisely these encounters, as happens through ration shop transactions in the PDS, bolstering the state's role in image-building. This allows governments to reposition themselves as innovative problem solvers and has the potential to influence the public opinion of the state.

Conclusion

It's important for policymakers and administrators to carefully plan and implement digitalization initiatives, considering the unique socio-economic context and needs of the population they serve. Balancing the advantages of technology with the inclusivity and accessibility of the system is crucial for a successful and equitable digitalized Public Distribution System.

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