Information systems in Indian food security infrastructure

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Abstract
PDS is Indian food security infrastructure for delivering food grains at subsidized prices to poor. It also focuses on local sourcing and community participation. We aim to study use of ICT for excellence in such not-for profit, community based supply chains, thus, attempts to link public policy and supply chain.

Keywords: Supply chain strategy, Food Security, Public Distribution System, ICTD

INTRODUCTION

One of the fastest growing economies of the world, India (as per the World Economic Outlook released in July 2015) growing at a rate of 7.3% in 2014 is expected to surpass China with projected growth rate of 7.5% for the year 2015. The country has lately witnessed enormous economic growth but still basic issue of food security is prevalent. The criticality of the situation is evident from the recent initiative of Government of India as a legal commitment for providing food security to over 75% of the population in the form of National Food Security Act, 2013. The act ensures the food rights of poor population by providing them food grain at subsidized prices all through the year. This legal commitment is carried out with the help of Public Distribution System (PDS) infrastructure, which was in operations since 1950s. The system not only aims to protect the financially weaker section of the society but it also aims to motivate farmers by giving them sufficient remuneration at sourcing end. Thus, it is responsible for safeguarding two vulnerable sections of the society. The wide scale operation of this not-for-profit scheme is jointly handled by the Central and State Government. Procurement, storage, transportation and bulk allocation of food grains fall under the purview of Central Government, whereas the distribution of food grains through Fair Price Shops (FPSs) was the responsibility of State Government. In order to carry out procurement and distribution, the locals are involved in

the form of village level communities and self-help organizations, thus, emphasizing on employment generation.

The operations of these schemes face many issues and usually perform sub-optimally, due to inherent challenges. Information and Communication Technology (ICT) has emerged as an important enabler of attaining performance excellence in business organizations. Also, the role of ICT in inducing relevant supply chain strategy and thus, achieving desired goal is also established in supply chain literature. While, there exist scant studies on community run, not-for-profit government schemes. This paper thus, aims to study the implementation and use of ICT and supply chain strategy of not-for profit, community based supply chains in the context of a developing economy. It, thus, attempts to link public policy and supply chain.

The paper is divided into four sections. Introduction section is followed by brief literature review on Public Distribution System, ICT for Development and supply chain strategy. The third section ICT in Chhattisgarh PDS discusses the process of ICT implementation in Chhattisgarh PDS along with the analysis based on ICTD literature and supply chain strategy.

LITERATURE REVIEW

Public Distribution System

Public Distribution System (PDS) is a food security infrastructure in India which is operational for more than six decades now. It was initially started for providing food security to urban poor. With the success of green revolution the sufficient food availability demanded the bulk procurement and movement of food grains from the rural sources to the urban demand centres. Also, due to the existence of small and pity farmers the expansion of this public service to the rural areas was must. Eventually, the present state of PDS evolved, covering almost entire length and breadth of the country for safeguarding the food rights of the poor and ensuring sufficient income to the farmers through procurement, thereby regulating the food grain prices (Nawani 1994). Till 2013, PDS was just an operational infrastructure which was formalized as policy after enforcement of National Food Security Act, 2013 which states that it is the government's responsibility "*to provide food and nutritional security in human life cycle approach, by ensuring access to adequate quantity of food at affordable prices to people to live a life with dignity and for matters connected therewith or incidental thereto.*"

The operation of PDS is jointly managed by Central and the state governments of India. The Central government procures and ensures the availability food grains to the state government for distribution. Food Corporation of India (FCI) as a representative of Central Government procures food grains from the farmers at pre-declared Minimum Support Price (MSP). FCI also takes care of the storage and allocation of food grains to the states for distribution. The states after lifting the designated quality of food grains from FCI warehouses distribute them through the network of Fair Price Shops (FPS). Due to self sufficiency of few states to fulfil their own demand, the Decentralized Procurement (DCP) scheme has been adopted by them, thus reducing the length of the supply chain.

PDS supply chain thus, starts from procurement of food grains from farmers and extends till its distribution to underserved community. Procurement activities are carried out by cooperative societies formed by farmers themselves. The procured food grains are then transported to mills or big warehouses for milling and storage respectively. The processed food grains ready for distribution are then deposited to the government's warehouses for distribution under PDS. The

distribution of food grains are carried out through the network of Fair Price Shops (FPS) to the poor beneficiaries. The government provides ration cards to all the poor families of the state which serves are the document for claiming PDS commodities. Each ration card is attached to a single FPS based in their locality. Thus, FPSs have definite number of buyers. Additionally, FPSs are also run by the community based organizations like, village panchayat, forest security, women self-help group, nagar nigam, cooperatives, etc.

Due to inherently different motives and operating conditions PDS supply chain is quite distinct from the conventional supply chains. Table 1, discusses the difference between PDS supply chain and conventional supply chain.

Table 1: Distinction between PDS Supply Chain and Conventional Supply Chain

Dimensions	**PDS Supply Chain**	**Conventional Supply Chain**
Objective (of chain)	Continuous supply	Cost Reduction
Focus	Welfare	Profit
Customers	Underserved, neglected and vulnerable	Enjoy money surplus, multiple options and power
Demand Variability	Low	High
Dominant Cost	Delivery cost	Marketability cost
Profit Margin	Low/Negative	Positive
Supply Chain Participants	Community based organizations, Government	Profit oriented professional participants
Supply Chain Relationships	Transactional-Government mediated	Collaborative/Strategic

In addition to above distinctions PDS supply chain posses following uniqueness: (1) *Seasonal and uncertain production*: Production of food grain is a long process which happens once or twice a year based on the agricultural cycle. Also, the production is highly dependent on weather and climate condition of the region. On the other hand, consumption is evenly distributed throughout the year. (2) *Handling and logistical needs*: Due to perishable nature of the food grains, they demand special storage and logistic requirements (Banerjee 2011). (3) *Geographically distributed market*: Even the location of production and consumption of food grains are not synchronized. All geographic locations do not have cultivable land and hence, long distance movement of food grain to match the demand of the region is a common phenomenon. (4) *Lack of professionalism*: Due to involvement of community based organizations at the procurement and distribution the chain witnesses a little lacks the professionalism (Rehman et al. 2012).

All these facts indicate that PDS presents a unique context due to its bulkiness, non-profit nature and social responsibilities towards underserved (poor) community. Also, the target population is not only financially weak but also lack awareness about their rights and duties due to poor educational qualification.

ICT for Development (ICTD)

ICT was mostly studied for its application and use in typical business organizations. It was only during the end of 1990s and starting of 2000s, the use of ICT was believed to facilitate social development (Avgerou 2010; Kleine & Unwin 2009). Since, then ICT literature has acknowledged this capability of ICT, thus, evolved a new stream called ICT for development

(ICTD or ICT4D). While, most ICTD research, though, tends to focus on the experiences and consequences of ICT development and use, rather than the limitations of technical resources that inhibit it (Avgerou 2010).

ICT innovation is an important aspect for implementation which over the years has been studied under two orientations addressing the issue of context: universalistic and situated. Universalistic perspectives state that ICT evolution is generic techno-economic reasoning independent of the social actors and circumstances. On the other hand, situated perspective considers the diversity of social actors as an important component of ICT innovation. Backing on this philosophy, Avgerou (2010) proposed distinctive discourses about ICT for Development along two dimensions of ICT projects: (1) Nature of ICT innovation process, which is either, Transfer and diffusion or socially embedded; and (2) Socio-economic transformation achieved through ICT- Progressive transformation or disruptive transformation. The nature of ICT innovation process determines emergence, implementation and development of an ICT project. If an already existing successful model is adopted for implementation in the current context, it is referred to as transfer and diffusion. On the other hand, if ICT project is developed without a template but based on prevailing social conditions and available resources then it is a socially embedded innovation. The development transformation explains the effect of ICT projects on the society. In case of progressive transformation it is equal and justifiable for all the section of the society, while, disruptive transformation is when the actions are unequally benefitting different categories of society which is often subjected to power dynamics (Avgerou 2010).

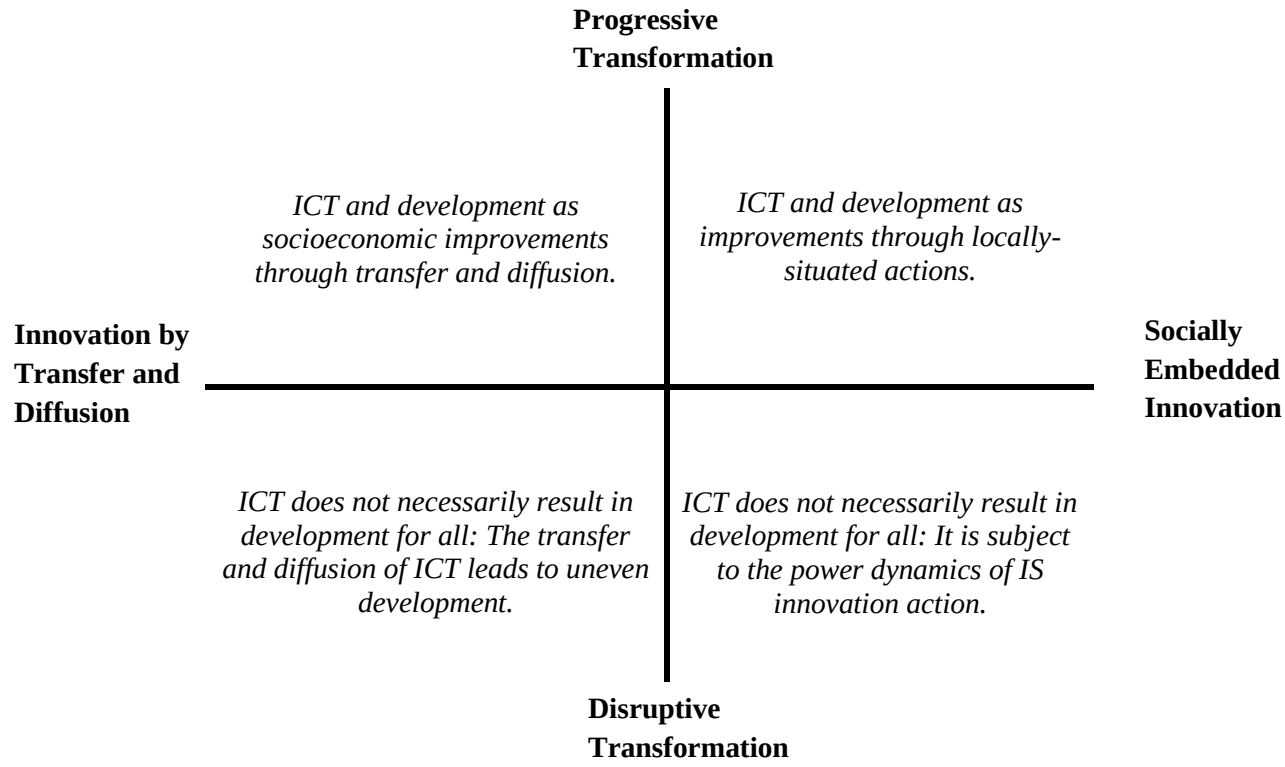

Figure 1: Four discourses of ICT (Source: Avgerou, 2010)

In a larger view, the implementation of information systems is problematic because of many intricacies. Many systems fail to live up to expectations and some end up as disasters (Myers 1995). Most of the literatures perceive ICT implementation as the introduction of IT at some

phase of system development cycle. Also, various authors study ICT implementation focusing on various aspects like, technology acceptance, which considers implementation as an exogenous force; organizational change, considering ICT implementation as a process oriented approach; or as an organizational problem solving involving mutual adaptation, which is not widely accepted. Many authors purport that the development of Information Systems is primarily a social process conducted within complex and intertwined set of social and political interactions. Further, the understanding of the organizational context and its history is crucial for the success of any ICT implementation (Myers, 1995).

Supply Chain Strategy

Supply chain strategies are mainly classified under two: lean and agile. Nalyor et al. (1999) defined lean paradigm means developing a value stream with objective of eliminate all waste including time at the same time ensuring level schedule. On the other hand, agile paradigm as the one using market knowledge and virtual corporation to exploit profitable opportunities in volatile and uncertain marketplace. The objective of agility is responsiveness (Yang 2014) and the service level is considered as the market winning criteria for an agile supply chain (Mason et al. 2000). Due to distinct objectives of the two strategies, the relationship between the two is widely argued. While, Nalyor et al. (1999) believe that lean and agile are two distinct strategies; Van Hoek et al. (2001) suggests agility to be an extension of lean thinking. The differences among the two strategies are discussed in table 2.

Table 2: Comparison between Lean and Agile Supply Chain Strategies

Dimensions	**Lean Strategy**	**Agile Strategy**
Objective	Elimination of waste	Responsiveness to the market
Focus	System focused	Market focused (Availability)
Product Variety	Low	High
Product Category	Functional/Commodity	Innovative/Fashion
Demand Variability	Low (Predictable)	High (Volatile)
Customer Drivers	Cost	Availability
Market Qualifier	Quality, Lead time, Service level	Quality, Lead time, Cost
Market Winner	Cost	Service Level
Integrated Supply Chain	Desirable	Obligatory
Product Life Cycle	Long	Short
Dominant Cost	Physical Product Delivery Cost	Marketability Cost
Information Enrichment	Highly Desirable	Obligatory
Profit Margin	Low	High
Production Strategy	Level production	Surge Production
Material Flow	Forecast driven PUSH	Demand driven PULL
Operating Policy	Maximum Utilization	Buffer Capacity

Forecast Mechanism	Algorithmic	Consultative
Supply Chain Relationships	Long term contractual	Short and virtual

Modified from Mason et al. (2000)

Information Technology is considered as an important enabler for lean as well as agile supply chains, by providing a platform for rapid information sharing and process integration. It also enables the effective de-centralized functioning within the system thereby promoting flexibility (Heim and Peng, 2010).

METHODOLOGY

In order to understand the implementation and use of ICT in Indian Food Security infrastructure, Public Distribution System (PDS), a case of Chhattisgarh has been selected. A case is a bounded entity which allows direct observation of the field (Yin, 2011; Seuring, 2008). Although the boundary between the case and its contextual settings in both spatial and temporal dimensions may be blurred, still it is a useful approach for accessing real world (Yin, 2011). And hence, case studies are used as a research method if contextual factors are taken into account (Seuring, 2008). While it is often criticized for lack of rigour, structured and well documented research process along with fulfilment of quality criteria (Case Selection, Data collection, validity and reliability) will be useful. Case method is very useful as inductive method of theory building (Eisenhardt & Graebne, 2007).

Chhattisgarh PDS is one of the widely acknowledged states in terms of ICT usage and implementation (*http://timesofindia.indiatimes.com/india/Gujarat-Chhattisgarhs-computerized-PDS-can-serve-as-model-for-all-SC/articleshow/9986934.cms*). Additionally, the state has excelled on use of ICT in an innovative manner to induce transparency. Hence, with the help of PDS portal, data on Chhattisgarh PDS are easily accessible. Also, being one of the first in successfully incorporating ICT in PDS, Chhattisgarh pose to be one of the extreme cases which can provide more information to theory as suggested by Eisenhardt & Graebne (2007).

Qualitative data in the form of semi-structured interviews, reports and news articles were collected. The duration of data collection was from Jan 2014 to July 2015.

ICT IN CHHATTISGARH PDS

ICT played key role in enhancing the performance of PDS in Chhattisgarh. The ICT implementations have been carried out in two phases. Phase one was computerization and integration of PDS supply chain, while, phase two was about automation of service delivery point.

ICT Implementation

Phase 1: Computerization & Integration of PDS

In 2007, the initiative of introducing ICT in Chhattisgarh's PDS was started, envisioned by the Food Department of the state and strongly backed by the state government providing strong political will and top management support. Due to huge coverage and impact of PDS, constrained skills and infrastructure, the project observed resistance and doubts. Still, it was

decided to start the project with two objectives: (i) Computerization of Paddy Procurement process, and (ii) Creation of Unified Ration Card Database.

Contextual issues prevented the use of any successful ICTD template, design was not clear. Hence, it was decided to go for simple and adaptable design as an incremental development. It was decided to develop form based front end applications in Hindi for each stakeholder (procurement centre, warehousing and millers) on dot net platform, which should be capable of working online and offline mode for data entry. Further, the database for ration cards was thought to provide a unique number with bar code, thus, avoiding issuance of duplicate ration cards.

The project of computerization of paddy procurement was started on 10th June 2007. The plan was to implement an end-to-end technology solution to integrate whole food grain supply chain of the state. Thus, addressing the problems of leakage and increase the efficiency of the system through real time information flow and enhanced monitoring. In order to address the issue of skilled labor force, each procurement centre was ordered to recruit one local data entry operator having basic knowledge of computer. Further, each data entry operator was provided with the training of 15 days on the respective modules. During training, user friendliness of the interface was tested and recommendations from the trainees were also considered and incorporated.

Despite the inaccessibility of various procurement centres, computerization of paddy procurement went live on 1st November 2007, the start of paddy procurement season for the year 2007. All the accessible locations were linked to the central server was through File Transfer Protocol (FTP) without any manual intervention. Motorcyclists with pen drive to carry data were hired for villages with no data connectivity. Eventually, with the expansion of mobile and internet their need was eliminated. Soon, the modules were enhanced to provide the facility of reporting, online farmer registration and bank transfers to farmers in their registered accounts.

All the orders were generated online and would reach to the concerned stakeholder through internet technology. Eventually, the provision of grievance redressal and social auditing were also adopted through citizen's web portal and call centres. Thus, achieving supply chain integration, information transparency in reduced lead time through ICT intervention.

Since, no pre-existing successful ICTD model was adopted for replication in the state, and the ICT innovation in Chhattisgarh PDS was evolved based on the socio-economic conditions and resource constraints, it was a socially embedded ICT innovation as per the Avgerou (2010) classification. Also, the benefit was intended for all the beneficiaries belonging to the weaker section of the society. Hence, the innovation was aimed to evenly benefit the targeted population by providing them food for sustenance. Thus, the first phase of ICT innovation in Chhattisgarh PDS falls in the quadrant of *Socially Embedded Innovation with Progressive Transformation*.

Furthermore, analyzing the role of ICT in PDS supply chain, it can be clearly stated that first phase of ICT implementation in Chhattisgarh PDS was aimed to improve leanness. The whole system was routinized, each and every activity was planned and the system for improving the supply chain integration was developed accordingly. Moreover, the characteristics of PDS, like, regular supply of food grains (commodity product), to the FPSs for distributing to the beneficiaries (for whom food means survival, thus basic food is sufficient; the volume of demand is also predictable, since the target population is known), etc. induces planning and lacks uncertainty. Thus, have a lean supply chain should be the desirable strategy.

Phase 2: CORE (Centralised Online Real-time Electronic) PDS

The next phase of ICT implementation was a service point automation projects planned soon after the stabilization of first phase of implementation. The objective was to improve service delivery, in terms of quality and quantity of PDS commodities; to check diversion, due to proxy issue; to break the monopoly of FPS; to induce transparency to weed out poor performers and most importantly to empower the beneficiaries. Empowerment was induced by providing choices to beneficiaries by allowing them to collect ration from any FPS, thus inducing competition among FPSs. Also, the ration cards of poor beneficiaries were substituted by Smart Ration Card (SRC), which were supposed to act as food ATM cards.

In 2012, the implementation of CORE PDS started in FPSs located in urban areas of Chhattisgarh after pilot study. Every FPS operating under CORE PDS scheme was provided with Point of Sale (PoS) device having General Packet Radio Service (GPRS) connectivity consisting of 2 smart card readers, finger print scanner and thermal printer, in order to capture the transactions online.

The replenishment of stock at FPS was a major issue which was initially performed by monthly allocations of food grains to FPSs based on the number of ration cards associated with the shop. But introduction choice to the beneficiaries demanded flexible stock replenishment at FPS. Since, the shop which is highly preferred by the beneficiaries will go out of stock soon while, the one which is preferred less will remain over stocked. This was handled using real time stock monitoring via PoS device. An order upto level of food grain inventory was replenished at each FPS based on the number of associated ration cards, transactions happening through PoS were recorded and the diminishing stock level is monitored which when reaches to the reorder level, a replenishment order was initiated for order upto replenishment of stock.

Also, in order to handle connectivity issues, the provision of limited transactions offline was also incorporated. The FPSs under CORE PDS started working as food ATMs, from where any beneficiary with SRC can collect his ration. This has introduced flexibility at the end of PDS supply chain.

CORE PDS aimed to furnish beneficiaries with empowerment, but the implementation in the last 3.5 years is restricted to FPSs located in urban areas. Thus, resulting in disruptive transformation; since, people in urban area with choices to collect ration from any FPS will be better off as compared to beneficiaries living in rural areas, who were bound to collect ration from the registered FPS. On the other hand, the ICT intervention was itself social embedded, as it took care of the resource constraints like, lack of electricity etc. prevalent in the contextual setting. Thus, the implementation of CORE PDS may shift the ICT implementation in the quadrant of *Socially Embedded Innovation with Disruptive Transformation*.

Also, looking from the supply chain strategy point of view, introduction of flexibility at the retailer end has introduced agility into the system. It provided flexibility to the beneficiaries to collect their rations from any FPS for which the system was prepared. Integrated supply chain, strong IT infrastructure, transparency and real time availability of stock level has enabled the system to introduce quantity flexibility in distribution of PDS commodities to the FPS. This way, the foundation of lean has helped in introducing agility into the system.

But, the coercive measures to implement CORE PDS have resulted in strong resistance during the implementation process by the FPSs in various regions, as their monopoly was at stake. Thus, there is a need to stress on the normative and mimic pressures among the FPS salesperson to acknowledge the role of CORE PDS schemes. Hence, benefits of using PoS devices like, expedited service delivery process, reduced manual efforts of documentation, and

lesser service time has to be stressed. Additionally, the major aspect of reluctance among FPSs in adoption of CORE PDS is threat to their monopoly. Thus, the stakeholder relationship in this condition is extremely important, as the supplier relationship is important for agile supply chains (Yusuf et al. 2004; Narasimhan et al. 2006).

Table 2 summarizes the two phases of ICT implementation in Chhattisgarh PDS, based on the development innovation using ICT and supply chain strategy adopted.

Table 2: Summarizing ICT implementation in Chhattisgarh PDS

	Phase 1: Computerization	**Phase 2: CORE PDS**
Objective	Computerization and Integration of PDS	Improving quality of service delivery for the poor beneficiaries
ICT Innovation	Socially Embedded Innovation with Progressive Transformation	Socially Embedded Innovation with Disruptive Transformation
Focus	Cost reduction and transparency	Flexibility and beneficiary empowerment
Supply Chain Strategy	Lean	Agile

The present case study of Chhattisgarh PDS, thus, provides evidences that use of ICT is important for excellence even in large scale public services. It also highlights the relationship between the objective, ICT innovation and the supply chain strategy implemented along two phases of ICT implementation. First phase, emphasising on leanness was focused more on simple design and training to use computer based application, while, second phase, targeted to introduce flexibility at the retail outlet is still not stable. Considering the changing power game due to implementation for the retailer (FPS) we recommend to influence more on the mimetic and normative pressures, which is presently, coercive.

CONCLUSION

The supply chain management literature has already established the relevance of Information and Communication Technology in the context of business organizations. But there is very little existent literature in the supply chain and operations management stream which explores the relevance of ICT in enabling the relevant supply chain strategy for not-for-profit public service schemes offered by government. This research using a case study of Chhattisgarh Public Distribution System discusses ICT implementation aimed for creating a relevant supply chain strategy for larger developmental goals.

Two phases of ICT implementation in Chhattisgarh PDS have different objectives. First phase developed a stable and routinized lean supply chain aiming for cost reduction and transparency, thus, providing an integrated supply chain. On the other hand, second phase backed on the foundation of lean was trying to introduce agility by providing flexibility at service delivery point. Thus, justifying the propositions that agility is preceded by lean, as suggested by van Hoek et al. (2001).

Thinking from the developmental goal point of view, first phase of implementation was completely on cost reduction to reduce financial burden on government and on inducing transparency to reduce corruption. Hence, increasing efficiency and better utilization of resources were the targets. Customers gain in terms of reliable and timely delivery due to

routinization was an indirect goal. On the other hand, second phase implementation was directly targeted towards beneficiaries empowerment in order to enable them to use their rights with dignity, while the system level changes were the processes involved.

Thus, ICT is capable of playing crucial roles in attaining developmental goals. But, slow and steady implementation process is essential, especially in a bulky system where community run organizations play important role.

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