# Challenges in technology adoption in Indian public distribution system: A quality management approach

**Abstract:** Information and communication technologies are increasingly being used by various countries to provide faster and transparent services to their citizens through e-government initiatives. A large population in developing countries remain deprived of these services due to lack of skills, training and infrastructure. Local community intermediaries who have the necessary skills to use e-government technology are employed to provide services to beneficiaries. Purpose of this study was to identify and prioritize the challenges faced by intermediaries in adopting new e-government technology by studying technology adoption of point-of-sale devices introduced in the public distribution system of Chhattisgarh. Quality management tools of list reduction and affinity diagram were used to organize the data and categorize the challenges into various areas to be addressed by government. Pareto chart was used to prioritize and identify the areas that required immediate attention. Utilization of quality management tools is an unconventional approach to problem solving in public administration sector. The six identified priority areas, in order of their importance, were lack of infrastructure, design of device hardware, process design, salespeople' errors, government support and software design. This research will help policy makers and government agencies to improve technology dissemination for easier adoption of existing as well as new e-government initiatives.

**Keywords:** E-governance, information and communications technology, technology adoption, quality management tools, list reduction, affinity diagram, pareto chart, food security, public distribution system.

## 1. Introduction and Background

Utilization of information and communication technologies (ICTs) to provide better services to citizens by increasing transparency of the public administration system and to empower citizens has been the focus of various countries (Meijer, 2007; Palvia and Sharma, 2007; Puri, 2012). Use of ICTs by government agencies to bridge the gap between government and citizens is referred to as e-governance. There remains a huge gap between the planned and actual use of e-governance initiatives in developing countries. Heeks (2001) categorized these gaps as hard–soft gaps, private–public gaps, and country context gaps. Hard–soft gaps are those that occur due to lack of consideration of social factors such as culture and politics while designing ICT for e-government systems (Heeks, 2001). Private–public gaps lead to e-governance failures due to public sector implementation of ICTs designed for the private sector (Heeks, 2001). E-governance initiatives designed for one country but implemented by another country leads to country context gaps (Heeks, 2001).

According to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), e-governance is defined as the use of ICTs in public sector with improved information and service delivery; higher citizen participation in the decision-making process; and effective, transparent, and accountable governance as the aim of these interventions (Palvia and Sharma, 2007). Findings of the current study provided insight into ways to improve information and service delivery as well as to increase stakeholders' participation by studying technology adoption of users' in an e-government initiative in India.

Even in 21st century, India struggles with widespread poverty and hunger, which accounts for more than 24% of the world's food insecurity (Food and Agriculture Organization of the United

Nations, the International Fund for Agricultural Development, and World Food Programme, 2014). Indian government runs various food security programs, yet the problem remains quite striking. In order to create more accountability of such food security program, the Indian government has started using various e-government initiatives. One example of such an initiative is the use of ICTs in distribution of subsidized food grains under India's public distribution system (PDS) to below poverty line households (Chopra and Rajan, 2016). Technology implementation is not the sole factor influencing the comprehensive transformation of public administration in the country. It is the adoption of technological innovation by users that leads to attainment of intended objectives (Chigona and Licker, 2008). Benefits of implementing ICTs in public sector cannot be appreciated without understanding the challenges faced by intermediaries in adopting new technology.

Part of the population in developing countries remain deprived of the benefits of technological interventions in government initiatives due to lack of exposure and limited infrastructure (Weerakkody et al., 2013). Here, exposure refers to the experience of beneficiaries with technology and infrastructure refers to (a) social infrastructure, such as information access and education; (b) physical infrastructure, such as better roads; and (c) institutional infrastructure, such as facilities that institutions have established to provide ICT education and training.

Skills of "ideal intermediaries" are required to bridge the gap between government and beneficiaries (Rajalekshmi, 2007; Sein and Furuholt, 2012). An ideal intermediary is an individual or organization capable of using ICTs based on the requirements of members of the community to which the intermediary belongs (Rajalekshmi, 2007). Successful implementation and utilization of ICTs require involvement of various intermediaries with government organizations, private firms, and cooperative societies being the major ones (Chopra and Rajan, 2016; Janssen and Klievink, 2009; Sein and Furuholt, 2012). Intermediaries often function as the primary users of ICT interventions by providing required services to secondary beneficiary users (Sein and Furuholt, 2012). Importance of studying the attitude of these intermediaries regarding technology is accentuated by the mandatory technology adoption scenario in e-governance (Chhabra et al., 2016). Mandatory adoption of technology in e-governance engenders various challenges specific to technology adoption by intermediaries, which makes this an important factor to study (Chopra and Rajan, 2016; Rana et al., 2013).

Weerakkody et al. (2013) emphasized the significance of studying technology adoption from the intermediary's perspective and ascertained a constructive citizen–government communication channeled through an intermediary. Understanding users' perceptions of technology within an entire process can help in providing better services by standardizing the design and use of ICTs (Al-Sobhi et al., 2010).

Traditionally, citizen utilization and adoption of ICTs was the focus of most of the research; recently however, various researchers have emphasized on the importance of studying the role, technology attitudes, and technology adoption of intermediaries in e-governance (Al-Sobhi et al., 2009; Al-Sobhi et al., 2010; Cecchini and Raina, 2004; Chopra and Rajan, 2016; Janssen and Klievink, 2009; Kumar and Best; 2006; Weerakkody et al., 2013). Ejiaku (2014) identified that existing research did not directly capture the difficulties faced by intermediaries when exposed to new technology, and hence, there is a greater need to study intermediaries' experiences with technology.

This study employed quality management tools to identify various challenges faced by intermediaries in adopting new technology implemented in the food security system of Chhattisgarh, India. Quality management tools include various diagrams, charts, tables,

techniques, and methods used to manage and improve the quality of products and processes through continuous improvement (Grover et al., 2016; Ramesh and Ravi, 2013; Tague, 2005). These tools help to increase profitability as well as customer satisfaction by continuous improvement of processes (Singh and Singh, 2014). The processes considered for this were various tasks performed in fair price shops, including receiving commodities from government agencies, authentication of beneficiaries, distribution of correct quantity of commodities, providing requested information to beneficiaries, and maintaining records of transactions. Various industries traditionally have employed quality management tools and techniques with the objective of providing better products and services to their customers (Chiarini, 2013).

Identified challenges were then categorized into major priority areas. In the context of this study, priority area refers to various themes into which the identified challenges were grouped based on apparent similarities among them. These themes were decided upon in a manner such that each theme could act as an area of improvement on which government agencies can focus for easier adoption of technology by intermediaries. These themes were then prioritized to identify the ones requiring immediate attention to successfully implement ICTs in future e-government initiatives and improve existing e-government systems.

### *1.1 Rationale for using quality management tools*

Employing quality management tools provide a novel approach for analysing ICT-related challenges in e-governance. In addition to providing solutions to a problem under consideration, data analysed using these tools are generally consolidated in a manner that can be easily transformed from theoretical information to actual practice (McQuater et al., 1995). The representation and terminology of the tools used are understandable by government stakeholders. Hence, the ease of understanding results would make the decision-making process less challenging for policymakers. Maxwell (2013) pointed out categorizing strategies as one of the methods to analyse qualitative data. As the name suggests, categorizing strategies helps to organize the qualitative data by grouping it into various categories (Maxwell, 2013). Use of quality management tools allow more information to be obtained by systematically organizing the data and expanding thinking to create a variety of ideas or focusing ideas to the particulars (Reid and Cseko, 2006; Tague, 2005).

Following subsections provide detailed information on food security system adopted by India, major technological intervention in Chhattisgarh food supply chain, and literature reviewed on challenges in ICT adoption.

### *1.2 Food security situation in India and the public distribution system*

Food and Agriculture Organization of the United Nations (FAO) defined food security as existing when “all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2006, p. 1). Currently in India, food access is a much bigger concern than is food availability (Khera, 2011).

The largest food security scheme of India is the PDS, which aims to provide physical and economic access to staple food grains (wheat and rice) and other essential commodities (sugar, salt, kerosene, etc.) to below-poverty-line (BPL) households (Khera, 2011). Access to food grains and other essential commodities is provided through a network of more than 535,000 fair price shops. Fair price shops are responsible for distribution of food grains and essential commodities

at subsidized rates to beneficiaries. India's PDS is one of the largest logistical food programs operating in the world.

In order to make distribution efficient and overcome black marketing, hoarding e-governance is essential (Chopra and Rajan, 2016). Indian government aims to computerize more than 50% of fair price shops by March 2017. The state of Chhattisgarh in Central India became a role model for other states by computerizing the PDS food supply chain in 2007–2008 and implementing the Centralized Online Real-Time Electronic Public Distribution System (COREPDS) in 2012 (Chhattisgarh Department of Food, Civil Supplies and Consumer Protection, 2012). Computerization of fair price shops reduce corruption indirectly by increasing transparency (Bathla et al., 2015). Increased transparency is achieved by making information widely available to all the involved stakeholders in the supply chain. Other benefits of implementing ICTs include user-friendly processes, reduced transaction time, easier analysis of transaction data, and easier beneficiary authentication (Chopra and Rajan, 2016).

### *1.3 ICT in public distribution system of Chhattisgarh*

Introduced in the PDS of Chhattisgarh in 2012, COREPDS aimed to empower beneficiaries, reduce commodity diversion, and provide better service to beneficiaries (Chopra and Rajan, 2016). Before the implementation of COREPDS, each beneficiary household was linked to one particular fair price shop. This created a forced monopoly of fair price shop owners leading to beneficiary exploitation and commodity leakage from the system (Chopra and Rajan, 2016). COREPDS aimed at overhauling the existing system by providing the option of portability to beneficiaries. With the introduction of portability, each beneficiary household was linked to all fair price shops and was given the right to choose the fair price shop from which they could buy their entitlements. The fear of losing beneficiaries created a competition between fair price shops and forced them to provide better services. Portability was bound to complicate commodity tracking, beneficiary identification, and transaction recording. Use of ICT was inevitable for a transparent and more efficient system. Hence, all fair price shops were equipped with point-of-sale (POS) devices with internet connectivity and beneficiaries were provided with a smartcard.

Each beneficiary is authenticated and checked for the eligible quantity by swiping the smartcard with the POS device. Salesperson then enters the required quantity of commodities, which is updated with the central server. The device generates a receipt, which is provided to the beneficiary, after which the payment is received and beneficiary can collect the commodities. Freedom to choose fair price shops and installation of POS devices empowered beneficiaries by eradicating the forced monopoly of fair price shops, providing better service, weeding out non-performing fair price shops, and reducing diversion of commodities through automated authentication of beneficiaries.

### *1.4 Challenges in technology adoption*

Heeks (2001) studied the extent of e-government failure and established that 35% of e-government initiatives are complete failures, 50% are partial failures, and only 15% are successes. Successful adoption of e-governance initiatives faces a variety of challenges. Rao (2004) studied rural ICT infrastructure and identified durable technology, degree of employee involvement, transparency, cost reduction, citizen convenience, process improvement, ease and strength of the public–private partnership arrangement, and increased revenue as major factors responsible for successful implementation of ICT projects.

Gichoya (2005) reviewed literature of ICT implementation in developing countries and categorized the factors affecting technology implementation into success factors and failure factors. He identified vision, strategy, government support, technological advancements, beneficiary expectations, effective project management, and ethical practice as the major drivers and enablers for success of ICT projects. Gichoya (2005) further identified infrastructure, funding, incompatible data systems, leadership style, culture, attitude, and lack of skill toward e-governance as the major barriers in the way of smooth implementation of e-government initiatives. Vision, strategy, and government support were mentioned as the most important success factors, and insufficient resources and lack of infrastructure were identified as failure factors.

Ejiaku (2014) discussed various challenges encountered in the adoption of ICT in developing countries and determined that infrastructure, training, government policies, and the country's culture were the major challenges. Infrastructure included telecommunication systems as well as human resources required to effectively operate these systems (Ejiaku, 2014). Training included providing sufficient education and skills to professionals involved in creating and maintaining the infrastructure (Ejiaku, 2014). Various policies and funding towards ICT infrastructure were related to the government's attitude and country's culture towards ICT (Ejiaku, 2014).

Abovementioned studies undertook a critical examination of ICT adoption in rural e-governance initiatives and therefore provided a broad list of challenges faced in adopting new technology. However, the research methodology of these studies did not take into consideration the opinion of primary users of introduced technology, which may have created a gap in the studies' analyses and actual challenges faced in field. Furthermore, the literature did not provide information on the importance of these challenges. This is important because some of the identified challenges may require more focus from government agencies compared to others. The present study attempted to fill this gap in the literature by creating an organized list of challenges faced by fair price shop salespeople in adopting POS devices and then creating a list of priority areas on which government agencies and policymakers must focus.

## 2. Methodology

In this section we describe the tools used to analyse data, participants, sample selection, survey instrument, and procedure of data collection and analysis.

### *2.1 Quality management tools*

Tague (2005) categorized quality management tools into six categories, which included (a) idea creation tools, (b) process analysis tools, (c) cause analysis tools, (d) data collection and analysis tools, (e) planning and implementation tools, and (f) decision-making and evaluation tools. Brief descriptions of these tools along with some examples are given in Table 1. Data analysis, idea creation, and decision-making tools were used in this study to analyse the data collected through questionnaire-based survey.

----------Table 1----------

*2.1.1 List reduction*. List reduction is a data evaluation and analysis tool used to narrow down a list of brainstormed options by removing duplicate and trivial ideas (José Tarí, 2005; Tague, 2005). The purpose of using this tool was to reduce the 71 ideas identified from the survey into a reasonable number by eliminating the options that were not related to the research objective and

combining the options that were similar to each other. Each idea was first evaluated by filtering the list and removing the ideas that were not related to the research objective. Then, each of the remaining ideas was compared to all others and identical ideas were then grouped as one challenge. A list of the processed data after applying list reduction is provided in the appendix. This list, obtained after using the tool, was the final list of 33 challenges faced by fair price shop salespeople in adopting the point-of-sales devices. These data were further analysed using an affinity diagram.

*2.1.2 Affinity diagram.* An affinity diagram is an idea-creation and brainstorming tool used to gather information and consolidate a large number of ideas into categories that have a natural affinity (Chansa-ngavej and Srijuntub, 2010; Tague, 2005). An affinity diagram can be used in any scenario where a large number of ideas are to be categorized under various themes. Grover et al. (2016) used an affinity diagram to group challenges faced by small food facilities in the adoption of preventive controls of food safety modernization act. Cheng and Leu (2011) employed an affinity diagram in the construction sector to analyse and classify common bridge construction defects into suitable groups based on the underlying similarities among them. The aforementioned literature shows the use of an affinity diagram to group challenges faced under two different scenarios. A similar approach was used in the current study to group the challenges obtained by list reduction into six themes or priority areas. The six priority areas were selected from the literature in a manner such that each priority area could be considered as an area requiring focus from government agencies and policymakers (Ejiaku, 2014; Gichoya, 2005; Omekwu, 2003; Rao, 2004). These focus areas were further prioritized using a Pareto chart.

*2.1.3 Pareto chart.* A Pareto chart is a bar graph used to prioritize a large number of brainstormed options and focus on the most significant ones (Tague, 2005). This chart is based on the Pareto principle, which states that 80% of the effects are caused by 20% of the causes (Oke et al., 2008). In context of this research, Pareto chart was used to prioritize the six identified areas to determine the most important areas of improvement on which policymakers should focus for better ICT adoption. The number of salespeople who stated a challenge in adopting POS devices was considered as the frequency of that particular challenge. The sum of all the challenges falling under each priority area was considered as the frequency of that particular area. The six priority areas were arranged in descending order of their frequency. Arranging them in decreasing order made it easier to distinguish the areas requiring higher attention from those requiring little or no focus.

Aforementioned methodology is diagrammed in figure 1. Top row shows the processing of data from collection to final outcome and bottom row shows the tools used to analyse the data at each step.

----------Figure 1----------

*2.2 Participant description and selection*

Participants in the study consisted of fair price shop salespeople who operated government-mandated POS devices to distribute food grains and other essential commodities. Salespeople working in fair price shops are responsible for receiving the commodities from government warehouses, displaying samples of food grains that the fair price shop is supplying, authenticating beneficiaries by their ration card, selling commodities to registered cardholders at the issue price specified by state government, and maintaining a record of each transaction. Use of POS devices

in fair price shops was the criterion of sample selection. Out of 218 fair price shops where POS devices were installed at the time of data collection (Chopra and Rajan, 2016), 170 usable responses were analysed by employing various quality management tools. Sample descriptive statistics of these responses are listed in Table 2.

----------Table 2----------

As shown in Table 2, more than 36% of the respondents were 21 to 30 years old, approximately 31% were 31 to 40 years old, and approximately 16% were from 41 to 50 years old, allowing us the opportunity to get the opinion of salespeople from various age groups. This is important because attitude towards new technology is different for younger than for older operators (Morris and Venkatesh, 2000). Similarly, experience with technology plays a vital role in developing one's attitude toward adopting it (Liao and Lu, 2008). Therefore, a variety in the experience of salespeople working in fair price shops as well as the variety in their experience with POS devices helped in understanding the challenges of technology adoption from the perspective of salespeople with different levels of experience.

*2.3 Survey instrument and data collection*

Information on challenges faced by fair price shop salespeople while adopting new technology was collected as a part of a larger survey conducted in three districts of Chhattisgarh in December 2013 by the second and third author. A questionnaire was prepared in the native language of participants (Hindi) to make it easier for them to understand what was being asked. The questionnaire consisted of 66 items, of which two open-ended questions asked the participant's opinion about POS devices and suggestions for modifications of POS devices as well as changes in business processes due to POS devices.

Responses to these questions were used to identify major challenges faced by fair price shop salespeople in adopting the POS devices to carry out daily transactions. Participants with an education level of bachelor's degree or higher were asked to complete the survey themselves, and a 10-minute interview was conducted to verify their responses (Chopra and Rajan, 2016). Interviews lasting from 45 minutes to 1 hour were conducted for all other participants, during which the questions were explained and responses to each question were recorded by interviewers (Chopra and Rajan, 2016).

*2.4 Data analysis*

Data collected were translated from Hindi to English, and the responses were kept anonymous during the analysis. Data were recorded and analysed in a Microsoft Excel® worksheet and a built-in Microsoft Excel® Pareto chart format was used to prioritize the major focus areas and challenges.

## 3. Findings

*3.1 List reduction and identified challenges*

Some of the observations in the 71 identified items were identical and could be placed under one challenge. An example of identical observations is that some of the salespeople mentioned that the device did not provide real-time information of the quantity of commodities sold as well as stock remaining in the fair price shop, whereas others mentioned that there was a difference in the quantity of stock available in fair price shop shown by POS device versus the actual stock in the

shop. These two points were aggregated into one challenge named real-time information of stock required.

Similarly, some of the responses were trivial for the purpose of this study and were not considered for further analysis. For example, some of the salespeople pointed out that they wanted shop hours to be increased to provide better service to beneficiaries. Others mentioned that fair price shops did not receive commodities on time when the stock was depleted, and they had to buy some of the commodities from the open market at higher prices to be able to serve the beneficiaries. Many times, available commodities were of poor quality and fair price shop salespeople had to get the grains cleaned themselves. Although observations like these were concerned with challenges faced by salespeople while making transactions, these were not related to adoption of POS devices. Hence, these challenges were removed from the list.

Once the trivial and duplicate ideas were removed, a final list of 33 challenges was identified. Identified challenges are described briefly in the appendix.

*3.2 Affinity diagram*

Affinity diagram with 33 challenges consolidated into six potential priority areas is shown in Figure 2. The six areas into which the challenges were divided were: device design (from both hardware and software points of view), process design, infrastructure, government support, and salespeople's errors. These themes were selected considering the general realms on which governments could focus for better adoption of technology in e-government initiatives. Some of the responses of fair price shop salespeople categorized on the basis of identified priority areas are exhibited in Table 3.

----------Figure 2----------

----------Table 3----------

*3.3 Pareto chart for priority areas*

The Pareto chart depicting the prioritized order of focus areas is shown in Figure 3. The rank order was as follows: (a) infrastructure, (b) device design: hardware, (c) process design, (d) salespeople' error, (e) government support, (f) device design: software. The number at the top of each bar represents the sum of frequency of challenges falling in each priority area. The line graph depicts the cumulative percentage of the frequency. The graph shows that approximately 75% of the challenges faced in technology adoption can be minimized by focusing on improvement in three areas: infrastructure, device hardware design, and process design. Salespeople' error, government support, and device software design were not immediate concerns on which to focus.

----------Figure 3----------

## 4. Discussion

Purpose of this study was to identify and prioritize challenges faced by users in technology adoption in e-government initiatives by analysing the adoption of POS devices introduced in the PDS of Chhattisgarh to distribute essential commodities, manage stock, reorder supplies, authenticate beneficiaries, and maintain records. Quality management tools were used to analyse the data. Findings from this systematic methodology of data analysis can be used to interpret and prioritize the technology adoption challenges for future e-government initiatives. This will help

government representatives and policymakers to focus on the top priority challenges that could help them channel funds to appropriate areas as well as optimize the use of resources. Moreover, the study demonstrates the use of quality management tools in the area of public administration and technology adoption. This provides an opportunity to use these tools in future studies related to adoption of technology as well as e-government and public administration challenges.

The prioritized list of challenges established lack of infrastructure as the biggest challenge faced by users in adopting new technology. Ejiaku (2014), Gichoya (2005), and Omekwu (2003) also identified lack of proper infrastructure, such as telecommunication systems and information technology personnel, to be a major hindrance in ICT adoption. Lack of ICT infrastructure is the reason for stagnated development of e-governance in developing countries (Ejiaku, 2014). Adding to the current literature, the present study found that lack of infrastructure comprised more than 33% of total challenges. The affinity diagram depicted that infrastructure consisted of three challenges. Providing better connectivity by employing a faster network, installing more than one device per shop, and establishing call centres to register and get solutions to new technology-related queries were the infrastructure related challenges faced by ICT users. This means that focusing on three of the 33 identified challenges could help in easier adoption of technology by resolving 33% of the challenges. Detailed planning of required infrastructure before establishing new technology and development as well as maintenance of ICT infrastructure could make it easier for users to adopt and employ ICT in their routine activities.

As shown in the Pareto chart (Figure 3), design of device hardware was the second most significant priority area identified by the study. Rao (2004) also identified technology design as a factor affecting successful implementation of new technology. Participants of the study mentioned device size, device speed, quality of display, and weak batteries among various challenges that made it difficult for them to carry out transactions efficiently. Approximately one fourth of the challenges were related to device hardware design, which leads to the suggestion that an ergonomically designed technological intervention is more likely to achieve easier ICT adoption. Ergonomics is a discipline of science that deals with the study of the relationship between humans and their environment through the design and use of equipment in such a way to minimize users' fatigue and optimize performance (Dul et al., 2012). Therefore, designing devices for e-government systems in a manner that makes them easier for the users to operate would lead to easier technology adoption.

The third most significant priority area identified in the study was process design, which constituted more than 15% of the total challenges. Rao (2004) suggested that process challenges can be a major barrier in implementation and adoption of new technology. Participants provided various suggestions for better processes that would lead to more efficient technology use. For example, one of the respondents mentioned that "money should be deducted directly from the beneficiary's smartcard and debited to fair price shop owner's bank account." They noted that linking beneficiaries' smart cards to their bank accounts and POS devices to fair price shop owners' bank account could lead to more efficient handling of money and better recordkeeping.

Salespeople' error was one finding that was not discussed in the literature. Errors due to human negligence contributed to 14% of the challenges. These errors included salespeople being slow in carrying out transactions, devices getting stolen, and errors being made while carrying out transactions.

Government support was mentioned as a concern in ICT adoption in most of the literature (Ejiaku, 2014; Gichoya, 2005; Rao, 2004), but this study found that it contributed to only 8% of the total challenges faced by ICT users in adopting new technology. This finding was consistent

with those of Chopra and Rajan (2016), who studied intermediary satisfaction with mandatory adoption of e-government technologies in the PDS of Chhattisgarh by using the Unified Theory of Acceptance and Use of Technology. The study revealed that facilitating conditions had nonsignificant effects on technology satisfaction (Chopra and Rajan, 2016). They defined facilitating conditions as the amount of training and support related to POS devices made available to fair price shop salespeople (Chopra and Rajan, 2016).

Software design comprised less than 5% of the total challenges. These challenges were related to software upgrades, provisions to obtain real-time information about stock on hand, stock information in the device according to beneficiary's category, lists of beneficiaries, and daily transaction records. Rao (2004) identified software design as an important factor in rural e-governance application and mentioned that the user interface must be in the regional language, record user transactions, maintain the privacy of beneficiary information, and be easy to upgrade. Most of the software-related challenges in the current study dealt with the requirement of having all job-related information in the device itself. This showed that the primary users of technology were concerned about not having all the information that they needed to perform their job.

Findings from this study may be used by policymakers and governments to focus resources on areas that need immediate attention and not to use resources on areas that do not require prompt action. Findings showed that resources could be judiciously utilized by channelling them into infrastructure, hardware design, and process design. This would solve three-fourths of the concerns of users in adopting new e-governance technology.

## 5. Conclusion and future work

This study identified and prioritized major challenges in adopting technology under the mandatory adoption scenario of e-governance. The six identified priority areas, in order of their significance, were lack of infrastructure, design of device hardware, process design, human error, government support, and software design. E-governance initiatives have a huge scope in both developing and developed nations. The findings from this research can help in the employment of technological interventions in future e-government measures.

Qualitative methods were utilized in this study to analyse the responses of users and gain understanding of the major challenges in adopting new technology in e-government initiatives. The findings of this study could be accompanied by a quantitative study to obtain a deeper understanding of the relationships and identify the challenges in technology adoption. This could help in providing deeper insight into the data by testing the hypothesis if the uppermost significant challenges were significantly related to technology adoption and the least significant challenges had a non-significant relation to technology adoption.

The challenges and order of priority areas identified in the study were based on new ICT implementation in the food supply chain of PDS of one of the states in India. Similar studies in e-government initiatives in other areas could bolster the findings of this study and also provide deeper understanding of areas on which government agencies must focus.

## Acknowledgements

We would like to thank our partners who supported our research: Department of Food, Civil Supplies and Consumer Protection, Government of Chhattisgarh; and A. K. Somasekhar and the COREPDS team at National Informatics Center (NIC), Chhattisgarh.

**References**


Al-Sobhi, F., Kamal, M. and Weerakkody, V. (2009) 'Current state of e-services in Saudi Arabia: The case of intermediaries in facilitating government services in Madinah city', in *European and Mediterranean Conference on Information Systems in Izmir, Turkey, 13-14 July 2009*.

Al-Sobhi, F., Weerakkody, V. and Al-Busaidy, M. (2010) 'The roles of intermediaries in the diffusion and adoption of e-government services', in *Sixteenth Americas Conference on Information Systems, Paper 385 in Lima, Peru, 12-15 August, 2010*.

Bathla, S., Bhattacharya, P. and D'Souza, A. (2015) 'India's National Food Security Act 2013: Food distribution through revamped public distribution system or food stamps and cash transfers?', *Agricultural Economics Research Review*, Vol 28. No. 1, pp. 39–55.

Cecchini, S. and Raina, M. (2004) 'Electronic government and the rural poor: The case of Gyandoot', *Information Technologies & International Development*, Vol. 2 No. 2, pp. 65–76.

Chansa-ngavej, C. and Srijuntub, A. (2010) 'Using Analytical Hierarchy Process for innovative technology selection: A case study', *International Journal of Innovation and Learning*, Vol. 8 No. 3, pp. 279-295.

Cheng, Y.-M. and Leu, S.-S. (2011) 'Integrating data mining with KJ method to classify bridge construction defects', *Expert Systems with Applications*, Vol. 38, pp. 7143–7150.

Chhabra, V., Rajan, P. and Chopra, S. (2016) 'Intermediary's technology satisfaction and performance in Chhattisgarh public distribution system: Research Note', in *Eighth International Conference on Information and Communication Technologies and Development (Article 47). Ann Arbor, MI, 3-6 June, 2016*.

Chhattisgarh Department of Food, Civil Supplies and Consumer Protection (2012) 'CORE PDS: Meri Marzi', Raipur, India.

Chiarini, A. (2013) 'Differences between six sigma applications in manufacturing and service industry', *International Journal of Productivity and Quality Management*, Vol. 12 No. 3, pp. 345-360.

Chigona, W. and Licker, P. (2008) 'Using diffusion of innovations framework to explain communal computing facilities adoption among the urban poor', *Information Technologies & International Development*, Vol. 4 No. 3, pp. 57–73.

Chopra, S. and Rajan, P. (2016) 'Modeling intermediary satisfaction with mandatory adoption of e government technologies for food distribution', *Information Technologies & International Development*, Vol. 12 No. 1, pp. 15–34.

Dul, J., Bruder, R., Buckle, P., Carayon, P., Falzon, P., Marras, W. S. and Doelen, B. (2012) 'A strategy for human factors/ergonomics: Developing the discipline and profession', *Ergonomics*, Vol. 55 No. 4, pp. 1–27.

Ejiaku, S. A. (2014) 'Technology adoption: Issues and challenges in information technology adoption in emerging economies', *Journal of International Technology and Information Management*, Vol. 23 No. 2, pp. 59–68.

Food and Agriculture Organization of the United Nations. (2006) 'Food Security', *Policy Brief*, Working paper, Issue 2, FAO Agriculture and Development Economics Division, Rome, Italy, June 2006.

Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, & World Food Programme. (2014)'The state of food insecurity in the world 2014: Strengthening the enabling environment for food security and nutrition', Rome, Italy: FAO.

Gichoya, D. (2005) 'Factors affecting the successful implementation of ICT projects in government', *The Electronic Journal of e-Government*, Vol. 3 No. 4, pp. 175–184.

Grover, A., Chopra, S. and Mosher, G. (2016) 'Food safety modernization act: A quality management approach to identify and prioritize factors affecting adoption of preventive controls among small food facilities', *Food Control*, Vol. 66, pp. 241–249.

Heeks, R. (2001) 'Understanding e-governance for development', i-Government working paper series. Paper no. 11, Institute for Development Policy and Management, University of Manchester, Manchester, U.K.

Janssen, M. and Klievink, B. (2009) 'The role of intermediaries in multi-channel service delivery strategies', *International Journal of Electronic Government Research*, Vol. 5 No. 3, pp. 36 46.

José Tarí, J. (2005) 'Components of successful total quality management', *The TQM magazine*, Vol. 17 No. 2, pp. 182–194.

Khera, R. (2011) 'India's public distribution system: Utilisation and impact', *Journal of Development Studies*, Vol. 47 No. 7, pp. 1038–1060.

Kumar, R. and Best, M. L. (2006) 'Impact and sustainability of e-government services in developing countries: Lessons learned from Tamil Nadu, India', *The Information Society*, Vol. 22 No. (1), pp. 1–12.

Liao, H.-L. and Lu, H.-P. (2008) 'The role of experience and innovation characteristics in the adoption and continued use of e-learning websites', *Computers & Education*, Vol. 51, pp. 1405–1416.

Maxwell, J. A. (2013), *Qualitative research design: An interactive approach, 3rd ed.*, Thousand Oaks, CA: Sage.

McQuater, R. E., Scurr, C. H., Dale, B. G. and Hillman, P. G. (1995) 'Using quality tools and techniques successfully', *The TQM Magazine*, Vol. 7 No. 6, pp. 37–42.

Meijer, A. (2007) 'Why don't they listen to us? Reasserting the role of ICT in public administration', *Information Policy*, Vol. 12, pp. 233–242.

Morris, M. G. and Venkatesh, V. (2000) 'Age differences in technology adoption decisions: Implications for a changing work force', *Personnel Psychology*, Vol. 53 No. 2, pp. 375–403.

Oke, S.A., Ofiabulu, C.E., Banjo, A.A., Akanbi, O.G. and Oyawale, F.A. (2008) 'The combined application of Quality Function Deployment and Pareto analysis for hotel services improvement', *International Journal of Productivity and Quality Management*, Vol. 3 No. 2, pp. 241-262.

Omekwu, C. (2003) 'Current issues in accessing documents published in developing countries', *Interlending & Document Supply*, Vol. 31, No. 2, pp. 130–137.

Palvia, S. C. J. and Sharma, S. S. (2007) 'E-government and e-governance: Definitions/domain framework and status around the world', in Agarwal. A. and Ramana, F.V. (Ed.), *Foundations of E-governance: 5th International Conference on E-governance, Hyderabad, India, 28-30 December 2007*.

Puri, R. (2012) 'Reforming the public distribution system: Lessons from Chhattisgarh', *Economic & Political Weekly*, Vol. 48 No. 5.

Rajalekshmi, K. G. (2007) 'E-governance services through telecenters: The role of human intermediary and issues of trust', *Information Technologies and International Development*, Vol. 4 No. 1, pp. 19–35.

Ramesh, N. and Ravi, A. (2013) 'TQM tools and techniques in promoting team working culture in the manufacturing organisations', *International Journal of Productivity and Quality Management*, Vol. 12 No. 4, pp. 466-479.

Rana, N. P., Dwivedi, Y. K. and Williams, M. D. (2013) 'A meta-analysis of existing research on citizen adoption of e-government', *Information Systems Frontiers*, Vol. 17, pp. 547–563.

Rao, T. P. R. (2004) 'ICT and e-governance for rural development', in *Symposium on Governance in Development: Issues, Challenges and Strategies, Institute of Rural Management, Anand, Gujarat, India, December 2004.*

Reid, R.A. and Cseko, G.C. (2006) 'Support service process improvement: An application within a University Health Sciences Center', *International Journal of Productivity and Quality Management*, Vol. 1 No. 4, pp. 339-362.

Sein, M. K. and Furuholt, B. (2012) 'Intermediaries: Bridges across the digital divide', *Information Technology for Development*, Vol. 18 No. 4, pp. 332–344.

Singh, J. and Singh, H. (2014) 'Performance enhancement of a manufacturing industry by using continuous improvement strategies – A case study', *International Journal of Productivity and Quality Management*, Vol. 14 No. 1, pp. 36-65

Tague, N. R. (2005), *The quality toolbox, 2nd ed.*, American Society of Quality Press, Milwaukee, WI.

Weerakkody, V., El-Haddadeh, R., Al-Sobhi, F., Shareef, M. A. and Dwivedi, Y. K. (2013) 'Examining the influence of intermediaries in facilitating e-government adoption: An empirical investigation', *International Journal of Information Management,* Vol. 33, pp. 716 725.

## Appendix

*Challenges Faced in Adopting Point of Sale Devices Grouped by Theme*

| Challenge | Description |
|---|---|
| **Device Design: Hardware** | |
| **Small device size** | Small device, buttons, and screen size made the device inconvenient for salespeople to use. |
| **Faulty touch mechanism** | Unresponsive devices made handling them inconvenient during transactions. |
| **High transaction time** | Slow device speed and slow working of salespeople led to longer transaction time and beneficiary dissatisfaction. |
| **Short battery life** | Short battery life made conducting transactions a challenge. |
| **Device display problems** | Inaccurate device display was a concern reported by salespeople. |
| **Device buttons malfunctions** | The device's buttons sometimes did not work properly and had to be pressed twice, slowing down service. |
| **Offline operation mode** | Using the device in offline mode was a challenge because stock did not get updated once the device was used in the offline mode. |
| **Device Design: Software** | |
| **Upgrade of software** | Software installed in POS device was old and needed upgrading. |
| **Device-generated daily transaction report** | Salespeople wanted devices to generate a daily transaction report at the end of each day so they could more easily track the quantity of each commodity sold to various cardholder types. |
| **List of beneficiaries in POS devices** | POS devices must contain a list of all the beneficiaries. |
| **Real-time stock information** | POS devices did not display real-time stock information; they did not update once a transaction was completed, leading to a mismatch in the actual quantity of commodities available and that shown by POS devices. |
| **Stock and price information by income category** | Because people in different income categories are eligible for different commodities at different costs, salespeople wanted stock eligibility and cost information to be made available on POS devices. |
| **Process Design** | |
| **Long wait time** | Long wait time and long queues made the process of carrying out transactions very time consuming, leading to impatience and quarrels between beneficiaries and fair price shop salespeople and also shop deterioration and loss of business due to high beneficiary dissatisfaction. |
| **Double entry of transactions** | Requirement of entering each transaction twice, both using POS devices and in the register after completing transaction was a challenge and deemed unnecessary by salespeople. |
| **Registering transactions later** | Salespeople wanted the government to allow them to register transactions later, after they provided commodities to beneficiaries, to help provide faster service. |
| **Automatic quantity entry** | Improved technology needed so that quantity to be distributed is automatically entered into the device and not required to be entered by the salesperson, who could misuse the system by entering the wrong quantity. |
| **Automatic money transfer between beneficiary and shop** | Handling cash was a challenge; salespeople wanted beneficiary smartcards to be linked to the shop's bank accounts so that money could be deducted directly from beneficiary's smartcard and debited to fair price shop owner's bank account, which would be a less complex process. |
| **Manual transactions when device doesn't work** | Salespeople wanted transactions to be processed through manual registers when they were unable to carry out transactions such as when POS devices broke down or did not work due to network issues. |
| **Link POS to Civil Supplies Corporation** | Link transactions from POS devices Civil Supplies Corporation (CSC, responsible for procuring food grains and other commodities from the Food Corporation of India and distributing them to fair price shops) so that once stock in the fair price |

| | |
|---|---|
| | shop was depleted , CSC was automatically informed and provided more stock om time. |
| **Serving beneficiaries without smartcards** | It was not possible to serve beneficiaries if they did not have their smartcard at the time of transaction. |
| **Multiple transaction entries at same time** | Only one transaction at a time were possible with POS devices, leading to longer wait times for beneficiaries, which led to dissatisfaction for both beneficiaries and salespeople. |
| **Providing commodities on credit using POS devices** | Salespeople wanted POS devices changed so that beneficiaries could pay at a later date in case they were out of cash, an acceptable practice before POS devices were instituted. |
| **Infrastructure** | |
| **Poor connectivity/ network/signal** | Poor network led to failed transactions which caused some customers to leave without their entitlements. |
| **More devices per shop** | Only one device was available for each fair price shop, which meant salespeople could only provide entitlements to one person at a time. |
| **Call centres needed** | Government must provide call centre facility where salespeople can get POS-related complaints and queries recorded and answered. |
| **Government Support** | |
| **Training** | Salespeople wanted basic training to solve various POS issues at their end. |
| **More field engineer support** | Salespeople wanted field engineers to be in contact with them more often. |
| **Government-provided insurance** | Government should provide the ability to get insurance because device damage and theft was a major concern. |
| **Ethernet cable** | Salespeople had to bear the cost of the ethernet cable when it got damaged. |
| **Supply costs** | Salespeople reported that buying paper rolls for billing was a challenge, and they wanted the government to either provide them or reimburse the amount they spent buying them. |
| **SIM recharge facility** | Government must provide facility to recharge SIM cards. |
| **Call centres needed** | *Repeat* |
| **Salespeople Errors** | |
| **Transaction errors** | Salespeople sometimes carried out wrong transactions due to their own errors. |
| **Theft of POS device** | Design of POS device was such that it could be easily stolen. |
| **High transaction time** | *Repeat* |

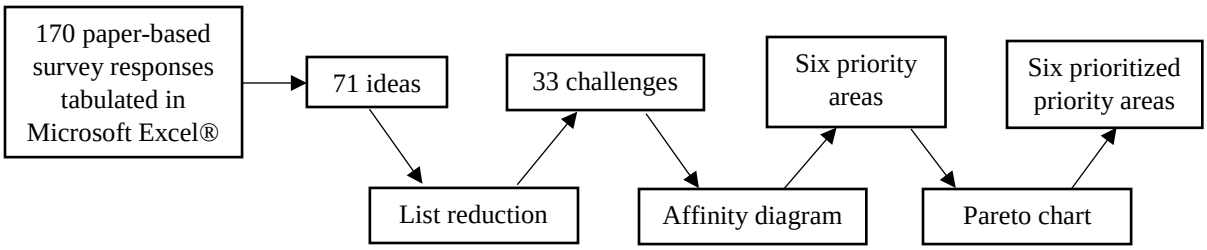


*Figure 1.* Flowchart showing research methodology

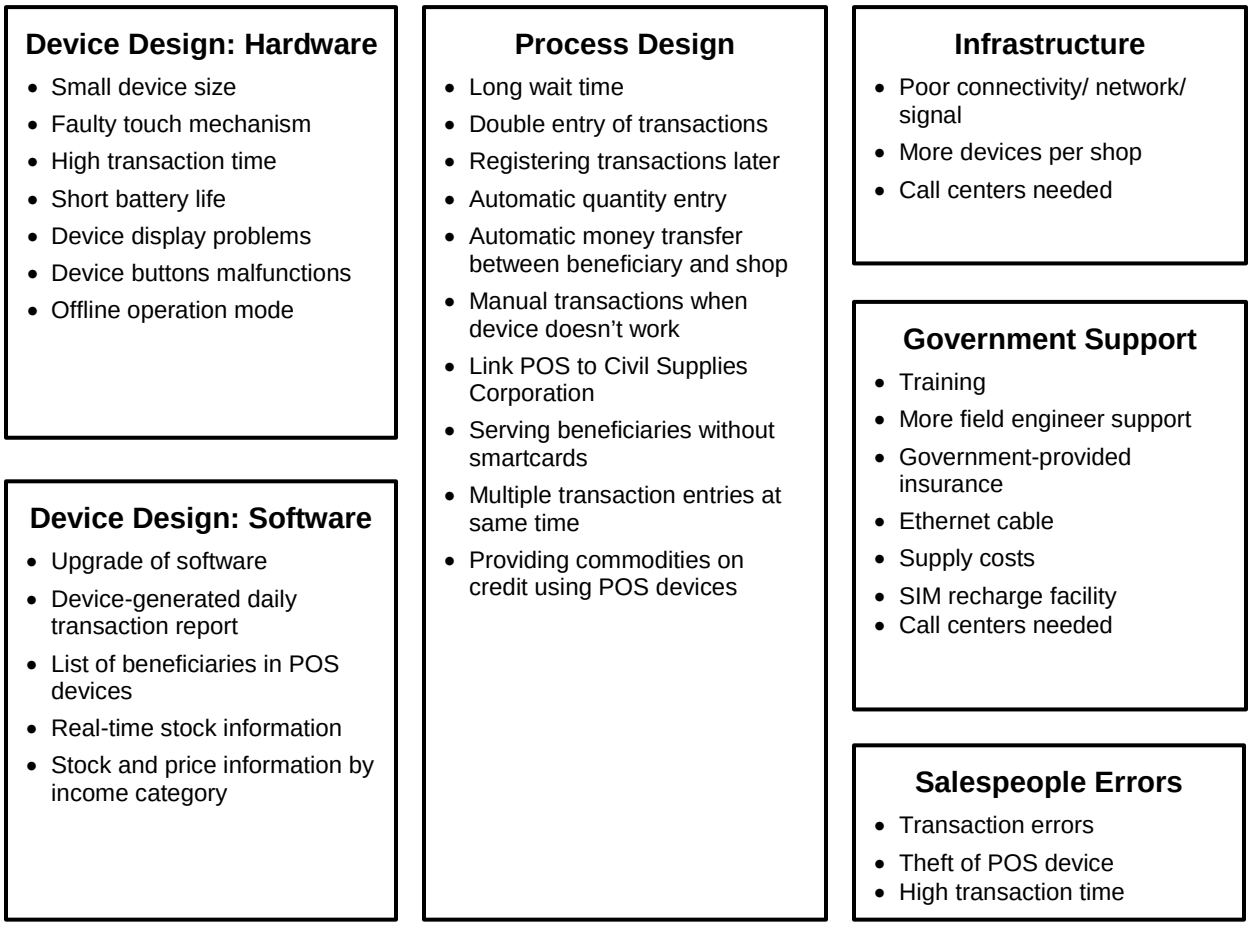


*Figure 2.* Six themes identified by affinity diagram

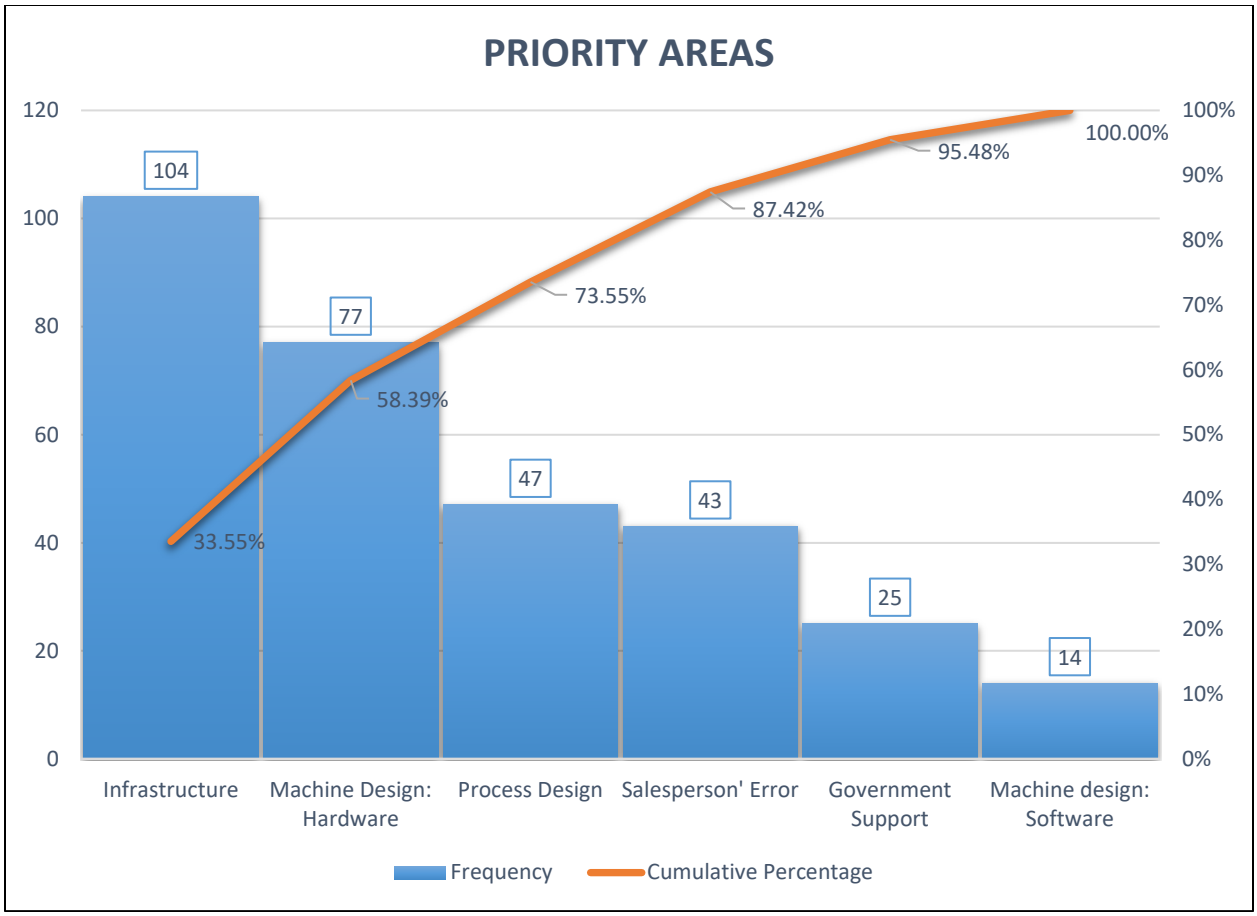


*Figure 3.* Pareto chart showing priority areas.

Table 1

*Types of Quality Management Tools: Description and Examples*

| Tools | Description | Examples |
|---|---|---|
| Idea creation tools | To create new ideas and to organize a complex list of ideas for easier analysis (José Tarí, 2005; Tague, 2005) | Affinity diagram, benchmarking, brainstorming, mind maps |
| Process analysis tools | To understand and analyse a process or a set of activities taken from the process (Tague, 2005). These tools are used for process planning, resource management, and analysis of work flow (Bal, 1998) | Flowchart, requirements table, critical to quality analysis, cause and effect analysis, relations diagram, work flow diagram, house of quality |
| Planning and implementation tools | These tools are used to manage projects from the project planning and initiation stages to the project implementation and completion stages (José Tarí, 2005) | Checklist, contingency diagram, project charter, presentations, arrow diagrams, potential problem analysis |
| Data collection and analysis tools | To collect and analyse data using standard charts, tables, and graphs (Bunney and Dale, 1997) | Pareto chart, box plot, control chart, run chart, stratification, sampling |
| Cause analysis tools | To help individuals and teams identify root cause of problems in order to avoid improper utilization of resources by employing them to address symptoms instead of the root cause (Sarkar et al., 2013) | Fishbone diagram, failure modes and effects diagram, fault tree analysis, scatter plot, why-why diagram |
| Decision-making and evaluation tools | To choose the best decision out of available choices and evaluate decision and project outcomes (Tague, 2005) | List reduction, decision matrix, decision tree, prioritization matrix |

Table 2

*Sample Descriptive Statistics*

| Variable | Frequency | Percentage |
|---|---|---|
| Age (years) | | |
| ≤20 | 4 | 2.35 |
| 21–30 | 62 | 36.47 |
| 31–40 | 52 | 30.59 |
| 41–50 | 27 | 15.88 |
| 51–60 | 13 | 7.65 |
| No Response | 12 | 7.06 |
| Gender | | |
| Female | 13 | 7.65 |
| Male | 153 | 90.00 |
| No Response | 4 | 2.35 |
| Experience with fair price shops (years) | | |
| ≤10 | 116 | 68.23 |
| 11–20 | 31 | 18.24 |
| ≥21 | 13 | 7.65 |
| No Response | 10 | 5.88 |
| Experience with POS devices (months) | | |
| ≤12 | 73 | 42.94 |
| 13–24 | 74 | 43.53 |
| ≥25 | 14 | 8.24 |
| Not available | 9 | 5.29 |
| Education level | | |
| Primary (Up to 5$^{th}$ grade) | 7 | 4.12 |
| Secondary (Up to 10$^{th}$ grade) | 50 | 29.41 |
| Higher Secondary (Up to 12$^{th}$ grade) | 54 | 31.76 |
| Bachelor's and higher | 55 | 32.35 |
| No Response | 4 | 2.35 |

Table 3

*Selected Responses of Fair Price Shop Salespeople*

| Priority area | Response |
|---|---|
| Device design: hardware | "Machines are too slow. Earlier it took a minute and now it takes more than 5 minutes to carry out a transaction. Shops get very crowded because of this." |
| Device design: software | "Information of commodities must be made available in POS devices according to beneficiaries' card color i.e. separate information for above poverty line, below poverty line, poorest of the poor etc." |
| Process design | "Three simultaneous transactions at same time must be allowed so that beneficiaries can be served faster." |
| Infrastructure | "Server problem should be solved at priority so that both fair price shop salespeople and beneficiaries do not face inconvenience." |
| Government support | "Training should be provided so that salesperson can themselves take some steps when machine stops working or when there is network problem." |
| Salesperson errors | "Sometimes transactions carried are wrong because of incorrect buttons pressed while carrying out transactions." |