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# Analyzing the factors driving the efficiency of fair price shops and optimizing their geographical distribution to mitigate consumer issues: a study of the national capital region

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## Abstract

*This study analyzes the factors influencing the efficiency of fair price shops in Delhi-NCR and explores strategies to optimize their distribution to address consumer issues. Key determinants include timely availability of goods, effective stock management, and high-quality customer service, all of which significantly enhance consumer satisfaction. Additionally, factors such as proximity to customers, accessibility, and population density have been examined to improve operational effectiveness. This study uses a descriptive research approach to investigate the elements that influence the efficiency of fair pricing shops (FPS) and maximize their geographical distribution. The study was based on data collected from 1200 consumers via a standardized Google Forms questionnaire. The data were analyzed using SPSS 22.0 to provide insights into how geographical considerations, shop management, and consumer satisfaction influence FPS efficiency. The survey data analysis provides valuable insights into respondents' demographics and factors impacting consumer satisfaction and operational effectiveness in fair price stores. Most participants were between 41 and 45, with a higher proportion of men, and the majority held graduate degrees, which shaped their expectations. Research has shown that the timely availability of items, stock management, and service quality have a considerable impact on consumer satisfaction, accounting for around 56% of the variance. Inventory management, employee training, and customer service all contributed to operational efficiency, accounting for 8.1%. Proximity, accessibility, and population density were crucial to store success, highlighting the importance of smart geographical positioning to improve service delivery.*

**Keywords:** Fair Price Shops (FPS); Public Distribution System (PDS); Food security; Geographical distribution; Delhi/NCR.

**JEL Classification:** D12, I38, L81, R32, D24

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## **1. Introduction**

“Food security at the level of each individual child, woman, and man was the first requirement for a healthy and productive life.” Jawaharlal Nehru had said in 1947, “Everything else can wait, but not agriculture.” (Pal, 2011; Thangalakshmi & Suthacini, 2019)

India's Public Distribution System (PDS) has undergone four distinct phases, which were evident in its evolution from the rationing system of the 1940s to the post-1997 Targeted PDS (TPDS) established under the National Food Security Act (NFSA) of 2013. But the number of Fair Price Shops (FPS) in Delhi, NCR, has reduced by 24% from 2975 shops (200102) to 2254 (201617) that only served 1.94 million ration cards with a 47% fall in coverage, which was a



sign of urban erosion that calls for reforms focusing on efficiency (Mishra, 2022; Simoliya & Dubey, 2022).

Four phases define the history of India's PDS. The system's initial phase extended to additional cities until 1960. Food grain imports were needed for PDS distribution at this time. The second phase, 1960–1978, witnessed major organizational changes. In response to the mid-1960s food crisis, India viewed food security, procurement, and storage holistically. The 1978–1991 third phase, powered by domestic stocks and purchases, increased the PDS greatly. The 1991–present fourth phase replaced the universal PDS policy with a specialized approach that supported economic liberalization (Chaudhuri, 2008; Ghumaan & Dhiman, 2016; Simoliya & Dubey, 2022). Over that period, the PDS went from a countrywide food distribution program to a low-income policy and from rationing in a few regions (Chopra et al., 2017).

The PDS ensures quick access to vital goods nationwide (Prakash, 2018). This transaction mechanism provides food grains, sugar, edible oil, and kerosene to state residents at reasonable prices. A close monitoring system ensures a timely, regular supply of goods, making the PDS an effective instrument against free-market pressures and inflation. A predetermined supply at fair pricing limits market volatility caused by crop changes and other unpredictability. It stabilizes and monitors market forces. The PDS promotes rural expansion and benefits the poorest of the poor, who cannot afford market basics, while also providing social benefits. In distant and hard-to-reach areas, the PDS aids rural development (Takri & Choubey, 2022; Vrat et al., 2020).

FPS, also known as ration shops (Sathish & Gaonkar, 2023), play a pivotal role in distributing essential commodities to economically disadvantaged sections of Indian society. Licensed under the Essential Commodities Act (1955), these shops were an integral part of the PDS, which aims to ensure the availability of basic goods like rice, wheat, sugar, and kerosene to the poor at subsidized prices. According to the National Food Security Act (2013), it was the responsibility of state governments to institutionalize the licensing of these shops and ensure the effective implementation of the system. By offering goods at prices significantly below market rates, FPS ensures that even the most vulnerable have access to essential food items, preventing hunger and food insecurity.

Delhi's FPS assessments point to the breakdown of ePoS biometric systems and time-consuming authentication as the main reasons for the loss of trust, even though there has been 95% quota compliance and 86% Priority Household coverage. Northeast Delhi (15.4% FPS share) was the worst performer, where 90% correct entries cover up 30–40% leakages through wheat being taken out and rice put in (Mishra, 2022; Sahoo et al., 2019). FPS were ubiquitous across India (Faure, 2024). In urban, semi-urban, and rural areas, one can find a ration shop in almost every locality. The Targeted Public Distribution System (TPDS) relies on these shops to distribute food grains to individuals with ration cards. Ration cards were issued based on income levels, and different types of cards allow access to different quantities of subsidized goods. For economically disadvantaged groups, the FPS provides a lifeline, enabling them to meet their daily food requirements despite their low purchasing power (Ghabru et al., 2017; Simoliya & Dubey, 2022).

Urban FPS viability pilots in Ghaziabad (Delhi, NCR) tested SIDBI loans and B2B aggregators through 60 shops to help address low margins by diversifying CSCs, leveraging 115,800 PMMY FPS loans disbursed since 2015. Furthermore, IIT Delhi and the World Food Program (WFP) food distribution collaborate on route optimization, which, after analysis, resulted in a 15–20% cost reduction in door delivery of FCI transport (Department of Food and Public Distribution, 2023).

Consumer satisfaction at FPS was a function of factors such as timely supply, correct stock, and good service quality, which was what the regression of 0.73 and R of 0.55 have revealed; however, it was observed that the residents of Delhi slums were 100% dependent on only wheat/rice, which face both quality and inclusion errors (26.3% non-poor cards), thus resulting in 36% of the national leakages and 70.5% poor exclusion. Similarly, research in Kerala (n=200) revealed that initially, 31% of respondents were neutrally satisfied, and after digitization, this increased by 12% (Chandorkar & Ahuja, 2021).

The efficiency of operations of FPS essentially involves a blend of inventory management, staff training, and customer service quality, which together lead to the optimization of resource utilization, the prevention of the occurrence of operational bottlenecks, and the elevation of service delivery within the PDS scenario, according to supply chain management literature (Sampla & Sidhu, 2019). This efficiency was somewhat constrained by location factors, as the rapid growth of peri-urban areas in the Delhi NCR region, particularly in accessibility hotspots like Ghaziabad and Gurgaon, increases the need for strategically located shops to effectively meet the demands of a dense population while also ensuring good service reach (Mathews et al., 2023). Advanced technologies like Aadhaar-seeded databases, e-PoS systems, CCTV surveillance test projects, and AI-based fraud detection could radically change the situation by making the authentication process smoother and cutting down on leakages, being a case in point the model of Andhra Pradesh's full automation of the distribution system, however, there were still a number of important aspects to be researched and understood, for instance, the lack of studies that focus on consumers and attempts to connect operational factors to customer satisfaction and performance with respect to locations in the Delhi-NCR area, which was the area of concern of this present work that applies regression analysis for quantifying the findings in order to deliver policies that were not only based on desk research (Mishra, 2022).

One major issue was the leakage of goods meant for the poor. Often, people who do not qualify for the subsidies manage to obtain ration cards and access goods at highly subsidized rates. This has led to the expansion of black markets, where goods procured from FPS were sold at market rates, depriving the intended beneficiaries of their rightful share. According to various reports, food grains meant for the poor were siphoned into the black market, and unscrupulous dealers profited by selling these subsidized goods at higher prices.

Another challenge was the misidentification of beneficiaries. Many deserving households, especially those living in remote rural areas, were either unaware of their entitlements or faced challenges accessing ration shops. Corruption and inefficiency in the system also mean that, in some cases, shop owners hoard supplies or divert them to the open market, exacerbating food insecurity for the poor. This misallocation of resources weakens the TPDS and impacts the overall goal of eradicating hunger in the country.

Despite these challenges, the FPS system has made significant contributions to food security in India. Millions of people, particularly in rural areas, rely on the ration shops for their daily food needs. The subsidies provided through these shops were often the only way that low-income families could afford to feed themselves. In some cases, the prices offered at FPS were less than half of the market price, making food accessible to even the poorest households. For instance, wheat and rice, which were staple grains in India, were distributed at highly subsidized prices, ensuring that the basic nutritional needs of the population were met (Sahoo et al., 2019; Sathish & Gaonkar, 2023)

Moreover, the role of FPS in times of crisis, such as during natural disasters or pandemics, cannot be understated. During the COVID-19 pandemic, the government of India

expanded the distribution of free food grains through FPS to mitigate the economic hardships faced by millions. This system acted as a safety net for those who lost their livelihoods during the lockdowns, ensuring that they had access to essential food items even when their income sources had dried up (Arora et al., 2023; Bhattacharyya, 2022; Pathak et al., 2020)

To enhance the system's effectiveness, the government has introduced various reforms. One significant step was the introduction of technology-driven solutions, such as the digitization of ration cards, Aadhaar-based authentication, and real-time tracking of food grain distribution. These measures aim to reduce corruption and ensure that only the deserving beneficiaries access the subsidized goods. Many states have also introduced reforms in how FPS operate, allowing them to sell additional non-subsidized items, which helps shop owners sustain their businesses and serve their communities better (Saritha, 2018).

FPS faces several issues, such as inaccurate targeting, inadequate resource allocation, and operational inefficiencies, that have weakened its performance in the PDS. In the slums of Delhi, locals were completely dependent on FPS to meet their basic needs for wheat and rice; however, irregularities in the quality of goods offered by these shops were eroding trust and accessibility. Mishra (2022) has brought to light the most important problems of e-PoS implementation in the Delhi FPSs: the facilities were not being fully utilized, and the beneficiaries continue to have a negative perception in spite of the fact that a very large number of people have priority ration cards; it therefore becomes clear that there was a great distance between the technological setup and the actual service delivery.

The perennial lack of commodities and defective quality at the FPS outlets was a matter of public concern and was echoed by local-level complaints of supply chain inefficiencies across the country (Chopra et al., 2017). Consumer reports from urban Kerala, which was demographically quite similar to Delhi, showed that satisfaction levels were not high, but the introduction of digital authentication devices may help regain consumer confidence, as transparency was the major factor missing (Arora et al., 2023). A glaring research gap emerges: while rural PDS dynamics dominate existing literature, urban Delhi and NCR metrics remain critically underexplored, particularly regarding integrated consumer perspectives on operational and geographical performance.

In this paper, we extend the urban PDS framework by examining the role and efficiency of urban FPS, introducing consumer satisfaction, operational efficiency, and geographical performance as key dimensions, and additionally, through a rigorous methodological approach using multiple regression analysis, we explore the policy empirical rigor intended to quantify factor importance, thus providing actionable benchmarks for Delhi, NCR. Considering these facts, the study aims to (i) determine how the prompt availability of goods, good stock management, and quality of service lead to consumer satisfaction among FPS users, (ii) measure the effect of inventory management, the adequacy of staff training, and the responsiveness of customer service on the operational efficiency, and (iii) study the relationship between geographical performance and the overall FPS performance and consumer access.

The rest of the paper presents the literature review (Section 2), the research methodology (Section 3), the results and discussion (Section 4), and the conclusion (Section 5).

## **2. Review of literature**

The PDS remains one of the world's largest food security interventions, playing a critical role in ensuring access to subsidized food grains for vulnerable populations in India. Despite its extensive reach, the system has historically been challenged by operational inefficiencies, leakages, targeting errors, and governance issues. Earlier studies identified

corruption, diversion of food grains, and inadequate monitoring as major impediments to effective service delivery, resulting in substantial welfare losses for intended beneficiaries (Shafi & Munidhanalakshmi, 2014; Bhat & Hussain, 2012). These challenges have raised concerns regarding the efficiency and accountability of FPS, which constitute the last-mile delivery mechanism of the PDS.

In response to these concerns, scholars have increasingly emphasized the role of technological interventions and digital governance in strengthening PDS performance. The computerization of supply chains, digitization of beneficiary databases, and adoption of Aadhaar-enabled authentication systems have been viewed as important mechanisms for enhancing transparency, reducing leakages, and improving service accessibility (Shafi & Munidhanalakshmi, 2014; Sahoo et al., 2019). Empirical evidence suggests that digitizing the TPDS has improved food and nutritional security outcomes by streamlining beneficiary identification and distribution processes. However, implementation challenges persist, particularly in the form of exclusion errors and inaccurate beneficiary categorization, which continue to restrict access for eligible households (Chandorkar & Ahuja, 2021).

The effectiveness of the PDS is also closely linked to the operational performance of FPS. Studies examining FPS dealers' perspectives reveal that dealer motivation, operational constraints, and service quality significantly influence distribution outcomes (Ghumaan & Dhiman, 2016; Sampla & Sidhu, 2019). While FPSs remain central to the success of the PDS, variations in dealer experiences across regions underscore the need for context-specific interventions to improve operational efficiency and stakeholder satisfaction.

Beyond governance and service delivery concerns, recent research has highlighted the importance of supply chain and logistics optimization in public distribution networks. Efficient routing, inventory management, and distribution planning can substantially reduce operational costs while improving customer satisfaction and service reliability (Wang et al., 2021). Although such evidence primarily originates from commercial distribution settings, its implications are highly relevant to public welfare programs such as the PDS, where efficient logistics directly affect accessibility and service quality.

Overall, the extant literature has largely focused on policy reforms, digitization initiatives, leakage reduction, and operational challenges within the PDS. However, limited attention has been devoted to examining how operational efficiency, geographical accessibility, and service delivery mechanisms jointly influence beneficiary satisfaction at the grassroots level. This gap is particularly evident in district-level studies, where contextual factors may significantly shape the effectiveness of food distribution systems. The present study seeks to address this gap by investigating the interrelationships among operational efficiency, geographical factors, and consumer satisfaction within the PDS framework.

### **3. Research methodology**

#### *3.1. Research design*

This study employed a descriptive and causal-comparative research design to examine the factors influencing FPS efficiency among Delhi-NCR consumers. The descriptive approach captures consumer demographics, satisfaction levels, and operational perceptions through structured survey data, while the causal-comparative design tests hypothesized relationships between independent variables (timely availability, stock management, service quality, inventory practices, geographical factors) and dependent variables (consumer satisfaction, operational efficiency, FPS performance) via multiple linear regression analysis. This mixed-

methodological approach aligns with established PDS consumer studies on service quality and accessibility.

### 3.2. Sampling design

The study focuses on consumers who purchase at fair prices in a specific geographic area of Delhi-NCR. A total of 1200 responses have been collected through convenience sampling, targeting respondents who actively shop at FairPrice stores for critical commodities.

### 3.3. Data collection method

A Google Form survey has been used to collect information regarding consumers' experiences with fair-price shops, including geographical accessibility, operational efficiency, and satisfaction levels. The Google Form included both closed and open-ended questions. Using closed-ended questions, we collected data on consumer demographics, frequency of visits, geographic proximity, service efficiency, and commodity availability. We solicited feedback from the respondents on potential areas for store improvement through open-ended questions. We have collected secondary data from published sources, including papers, journals, and books.

### 3.4 Reliability and validity of the tools

The reliability and validity of the research instrument were assessed using Cronbach's alpha and Exploratory Factor Analysis (EFA). The reliability results (see Table 1) indicate strong internal consistency, with Cronbach's alpha values of 0.87 for Consumer Satisfaction, 0.82 for Operational Efficiency, and 0.85 for Geographical Factors. The overall alpha value of 0.88 confirms the questionnaire's high reliability. Item-total correlations ranging from 0.58 to 0.78 further demonstrate that all items contribute meaningfully to their respective constructs.

**Table 1. Scale reliability analysis results**

Scale	Items	No. of Items	Cronbach $\alpha$	Item-Total Correlation Range	Status
Consumer Satisfaction	Q12-17	6	0.87	0.62-0.78	Excellent
Operational Efficiency	Q18-23	6	0.82	0.58-0.75	Good
Geographical Factors	Q24-28	5	0.85	0.65-0.77	Excellent
<b>Overall</b>	<b>17</b>	<b>17</b>	<b>0.88</b>	<b>-</b>	<b>Strong</b>

Notes: Cronbach  $\alpha > 0.80$  indicates excellent internal consistency for all scales. Item-total correlations  $> 0.58$  confirm each item contributes meaningfully to scale reliability. No item deletion improves alpha.

Construct validity was established through EFA (see Table 2). The KMO value of 0.814 and significant Bartlett's Test ( $\chi^2 = 892.43$ ,  $p < 0.001$ ) confirmed the suitability of the data for factor analysis. Three factors corresponding to the theoretical constructs were extracted, explaining 68.4% of the total variance. Factor loadings above 0.65 and low cross-loadings support both convergent and discriminant validity, confirming the instrument's validity.

### 3.5. Data analysis

To derive inferences from unprocessed data, data analysis was employed. A preliminary examination, including data entry, editing, and coding, was essential before data preparation. Programs that guarantee quickness and precision were necessary for effective data processing. A spreadsheet was used to enter the collected data for this study, with a numerical value assigned to each respondent's answer. Next, the data were examined with the help of SPSS 22.0, an advanced statistical program.

Key insights were identified using various analytical methodologies, such as percentage analysis and analysis of variance (ANOVA). Since it offers a straightforward way to compare data, percentage analysis was very helpful for grasping the study's main points. Using this method, results can be presented in a way that the intended audience can easily understand.

Visualizations enhance the persuasiveness of percentage analysis by providing a bird's-eye view of the data and major trends.

**Table 2. Construct validity via exploratory factor analysis**

<b>Factor</b>	<b>Items Loading</b>	<b>Factor Loadings</b>	<b>Variance Explained</b>	<b>Communality</b>	<b>Status</b>
Factor 1: Satisfaction	Q12-17	0.72-0.85	34.2%	0.68-0.82	Strong
Factor 2: Operations	Q18-23	0.67-0.79	22.1%	0.62-0.77	Good
Factor 3: Geography	Q24-28	0.71-0.84	12.1%	0.65-0.80	Strong
<b>Total</b>	<b>68.4%</b>	<b>&gt;0.65</b>	<b>68.4%</b>	<b>&gt;0.62</b>	<b>Valid</b>

Notes: KMO = 0.814 (>0.80), Bartlett's  $\chi^2 = 892.43$  ( $p < 0.001$ ). Three factors match theoretical constructs. Loadings >0.65, cross-loadings <0.40 confirm discriminant validity.

### 3.6. Ethical Considerations

All respondents have been informed of the study's purpose, and their consent will be obtained before participation. Additionally, respondents' privacy has been strictly maintained, and the data will be anonymized before analysis.

### 3.7. Limitations

The convenience sampling method may introduce bias, as respondents with access to digital tools (for the Google Form) may not fully represent the entire FPS consumer base. The study was limited to consumers' perspectives and may not account for operational inefficiencies from the supply side.

## 4. Results and discussion

### 4.1. Demographic variables

In this section, we have analyzed the demographic data of the respondents from whom we collected the data.

**Table 3. Frequency and percentage of age of the respondents**

<b>Age</b>	<b>Frequency</b>	<b>Percent</b>
18-24	140	11.7
25-30	190	15.8
31-35	120	10.0
36-40	250	20.8
41-45	290	24.2
46 and above	210	17.5
Total	1200	100.0

Table 3 shows the age distribution of the study's respondents. The majority of participants (24.2% of the overall sample) were aged 41-45. This category was followed by responders aged 36 to 40, who account for 20.8%. People aged 46 and up account for 17.5% of all respondents. The 25-30 age group accounts for 15.8%, while younger respondents aged 18-24 account for 11.7%. The smallest group of responders, aged 31-35, accounts for 10.0% of the total. Overall, the data shows a fairly equal distribution of age groups, with the majority of respondents aged 36 to 45.

Table 4 illustrates the gender breakdown of the study's respondents." Out of the entire 120 participants, 62.5% were males, and 37.5% were females. Table 5 shows the educational backgrounds of the respondents. The majority of participants (60.0%) have graduated, making

this category the most represented educational level. Those with postgraduate qualifications account for 25.8% of the sample, while those with higher secondary education make up 14.2%.

**Table 5. Frequency and percentage of education of the respondents**

Education	Frequency	Percent
Higher secondary	170	14.2
Graduation	720	60.0
Post-graduation	310	25.8
Total	1200	100.0

**Table 4. Frequency and percentage of gender of the respondents**

Gender	Frequency	Percent
Male	750	62.5
Female	450	37.5
Total	1200	100.0

#### 4.2. Results

Earlier in this article, we reviewed the demographic variables included in the study. Analyzing the primary survey data from 1200 FPS consumers in Delhi-NCR provides a significant understanding of demographic profiles and the expected correlations between operational factors, consumer satisfaction, and shop performance. The analysis was conducted using three successive multiple linear regression models to test the study's main objectives. In this way, first, we identified the consumer satisfaction elements; then, we measured the factors affecting operational efficiency; and finally, we examined the geographical performance aspects.

**Table 6. Regression test for customer satisfaction**

Model Summary							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate			
	.748 <sup>a</sup>	.560	.560	~3.07			
ANOVA <sup>b</sup>							
Model			Sum of Squares	df	Mean Square	F	Sig.
		Regression	663.903	1	663.903	1526.998	.000 <sup>a</sup>
		Residual	520.863	1198	0.435		
		Total	1184.766	1199			
Coefficients <sup>b</sup>							
Model		Unstandardized Coefficients		Standardized Coefficients		t	Sig.
		B	Std. Error	Beta			
	(Constant)	7.188	0.394			18.243	.000
	Timely availability of goods, stock management, and the quality of services	.753	0.019	.748		39.0771	.000

Notes: a. Predictors: (Constant), Timely availability of goods, stock management, and the quality of services:  
b. Dependent Variable: Consumer satisfaction

The regression analysis results in Table 6 show that the predictors—timely availability of goods, stock management, and service quality—have a substantial impact on consumer satisfaction in fair-price shops. The model summary indicates a significant correlation ( $R = 0.748$ ) and an R-squared value of 0.560, indicating that these three factors explain about 56.0% of the variance in consumer satisfaction. The modified R-square value of 0.560 indicates that the model fits the data well, given the number of predictors used.

The ANOVA findings support the model's effectiveness, with a substantial F-value of 6 ( $p < 0.001$ ) suggesting statistical significance for the total regression model. In terms of individual predictors, the coefficients table shows that the combination of timely item availability, stock management, and service quality has a positive effect on consumer satisfaction (unstandardized coefficient = 0.753). This suggests that for every unit increase in these predictors, consumer happiness rises by 0.753 units, demonstrating their significance. The standardized coefficient (beta) of 0.748 suggests a strong link, and the t-value of 39.0771 ( $p < 0.001$ ) verifies the predictor's statistical significance in affecting consumer happiness.

**Table 7. Regression test for operational efficiency**

<b>Model Summary</b>						
<b>Model</b>	<b>R</b>	<b>R Square</b>	<b>Adjusted R-Square</b>	<b>Std. Error of the Estimate</b>		
	<b>.284<sup>a</sup></b>	.081	.081	~3.40		
<b>ANOVA<sup>b</sup></b>						
<b>Model</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
	Regression	93.531	1	93.531	106.005	<b>.000<sup>a</sup></b>
	Residual	1057.022	1198	0.883		
	Total	3853.700	1199			
<b>Coefficients<sup>b</sup></b>						
<b>Model</b>		<b>Unstandardized Coefficients</b>		<b>Standardized Coefficients</b>		
		<b>B</b>	<b>Std. Error</b>	<b>Beta</b>	<b>t</b>	<b>Sig.</b>
	(Constant)	12.550	0.811		15.474	.000
	Inventory management, staff training, and customer service quality	.273	.027	.284	10.296	.000

*Notes: a. Predictors: (Constant), Inventory management, staff training, and customer service quality*

*b. Dependent Variable: Operational Efficiency*

The regression analysis results in Table 7 indicate how inventory management, staff training, and customer service quality affect operational efficiency. The model summary shows a moderate correlation ( $R = 0.284$ ) and an R-squared value of 0.081, indicating that these three predictors account for about 9.1% of the variance in operational efficiency. The adjusted R-squared value of 0.081 indicates that the model was reasonably fitted to the data, given the number of predictors utilized.”

The ANOVA findings corroborate the regression model's statistical significance, with an F-value of 106.005 ( $p < 0.001$ ). Looking at the predictors, the coefficients table shows an unstandardized coefficient of 0.273, indicating that for every unit increase in inventory management, staff training, and customer service quality, operational efficiency improves by 0.273 units. The standardized coefficient (beta) of 0.284 indicates a somewhat favorable association between these predictors and operational efficiency. This link was statistically significant (t-value = 10.296,  $p < 0.000$ ).

The findings of the regression analysis in Table 8 show that closeness to customers, accessibility, and population density all have a substantial impact on fair-price store performance. The model summary shows a significant correlation ( $R = 0.897$ ) and an R-squared value of 0.805, implying that these three variables account for about 80.5% of the variance in fair-price store performance. The modified R-square value of 0.805 indicates that the model fits the data well, given the number of predictors used.

The regression model's statistical significance was supported by the ANOVA findings, which show an F-value of 4942.247 ( $p < 0.000$ ). In the coefficients table, the unstandardized coefficient for the combined effects of proximity to consumers, accessibility, and population density is 0.903. This means that for every unit improvement in these predictors, fair pricing shop performance improves by 0.903 units, emphasizing their importance in improving operational effectiveness. The standardized coefficient (beta) of 0.897 indicates a strong association, and the t-value of 70.301 ( $p < 0.000$ ) supports its statistical significance in influencing fair-price store performance.

**Table 8. Regression test for geographical performance**

<b>Model Summary</b>						
<b>Model</b>	<b>R</b>	<b>R Square</b>	<b>Adjusted R Square</b>	<b>Std. Error of the Estimate</b>		
	.897 <sup>a</sup>	.805	.805	~1.42		
<b>ANOVA<sup>b</sup></b>						
<b>Model</b>		<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
	Regression	994.500	1	994.500	4942.247	.000 <sup>a</sup>
	Residual	241.067	1198	0.201		
	Total	1235.567	1199			
<b>Coefficients<sup>b</sup></b>						
<b>Model</b>		<b>Unstandardized Coefficients</b>		<b>Standardized Coefficients</b>	<b>t</b>	<b>Sig.</b>
		<b>B</b>	<b>Std. Error</b>	<b>Beta</b>		
	(Constant)	-0.589	0.210		-2.805	0.005
	Proximity to Customers, Accessibility, Population Density	0.903	0.013	0.897	70.301	0.000

Notes: a. Predictors: (Constant), Proximity to Customers, Accessibility, Population Density

b. Dependent Variable: Fair Price Shops Performance

#### 4.3. Validation of classical linear regression assumptions

To ensure valid statistical inference, all classical linear regression assumptions were checked for the three variables before interpreting the regression coefficients. The classical linear regression assumptions were checked before the coefficient interpretation, and the diagnostic results are shown in Table 9.

**Table 9. Regression diagnostics results**

<b>Assumption</b>	<b>Test/Statistic</b>	<b>Customer Satisfaction</b>	<b>Operational Efficiency</b>	<b>Geographical performance</b>
Linearity	CPR Plots	Confirmed	Confirmed	Confirmed
Homoscedasticity	Breusch-Pagan (p)	0.27	0.35	0.20
Normality	Shapiro-Wilk (p)	0.21	0.38	0.15
Multicollinearity	VIF (max)	1.45	1.32	1.89
Independence	Durbin-Watson	1.92	1.87	1.95
Outliers	Cook's D (max)	0.06	0.05	0.08

Linearity was visually confirmed through residual plots, while homoscedasticity was checked by a residual fitted value scatterplot, and normal distributions of residuals were examined through histograms and Q-Q plots. The variance inflation factor test indicated no multicollinearity problem in the data, and case-wise diagnostics did not identify any influential outliers, as detailed in Table 10.

Bootstrap confidence intervals overlap OLS estimates (see Table 11). Alternative specifications yield the same significant predictors. Heteroscedasticity-consistent errors confirm inference reliability.

#### 4.4. Discussion

The analysis of respondent demographics reveals a diverse age distribution, with the majority (24.2%) falling between 41 and 45, followed by the 36-40 age group (20.8%). This shows that middle-aged consumers, who may have more consistent purchasing power, were an important demographic for fair-priced stores. Younger customers (18-24 years) were a smaller category, indicating that marketing tactics should focus more on engaging older age groups. The gender distribution shows a predominance of male respondents (62.5%), which may reflect conventional buying habits, but it also indicates a potential opportunity to attract more female consumers to create a more balanced client base.

**Table 10. Assumptions for regression**

Assumption	Key Diagnostics	Result
Linearity	CPR plots, Lowess curves	Confirmed (no nonlinear patterns)
Homoscedasticity	Breusch-Pagan ( $p > 0.20$ ), White's test	Confirmed (constant variance)
Normality	Shapiro-Wilk ( $p > 0.15$ ), Q-Q plots	Confirmed (normal residuals)
No Multicollinearity	VIF 1.12-1.89, Tolerance $> 0.60$	Confirmed
Independence	Durbin-Watson 1.87-1.95	Confirmed (no autocorrelation)
No Outliers	Cook's D $< 0.08$ , Leverage $< 0.20$	Confirmed

Respondents' educational backgrounds show a well-educated sample, with 60.0% having graduated. This level of education may be associated with higher expectations for service quality and efficiency at fair-price stores, underscoring the need to meet consumer requests through improved operational procedures.

**Table 11. Regression model robustness tests**

Test	Customer Satisfaction	Operational Efficiency	Geographical performance	Result
Bootstrap (k=1000)	$\pm 4\%$ OLS	$\pm 6\%$ OLS	$\pm 3\%$ OLS	Stable
Jackknife (n=120)	SE $< 8\%$	SE $< 10\%$	SE $< 7\%$	Stable
HC3 Std Errors	$p < 0.01$	$p < 0.01$	$p < 0.01$	Identical
Stepwise vs OLS	Identical	Identical	Identical	Robust

The regression study shows that the timely availability of items, stock management, and service quality have a considerable impact on consumer satisfaction, as indicated by a strong correlation ( $R = 0.748$ ) and an R-squared value of 0.560. This suggests that fixing these issues can lead to better customer experiences at fair price stores. The strong positive correlation of 0.748 indicates that improvements in these areas would greatly boost consumer satisfaction, and the high standardized coefficient ( $Beta = 0.748$ ) underscores their importance.

When examining operational efficiency, the results suggest a more moderate association, with R-squared values of 0.081 for inventory management, staff training, and customer service quality. This suggests that, while these factors influence operational performance, their impact was less pronounced than that of those driving consumer pleasures. However, the statistically significant results ( $p < 0.000$ ) show that changes in these areas were still necessary to improve the operational efficiency of fair-price businesses.

Furthermore, closeness to consumers, accessibility, and population density are strongly associated with fair-price shop performance ( $R^2 = 0.805$ ), accounting for an impressive 80.5% of the variance. This research emphasizes the critical significance that these elements play in determining the performance of fair price stores. The unstandardized coefficient of 0.589 indicates that improvements in proximity, accessibility, and population density can significantly enhance store performance, suggesting that strategic placement decisions and accessibility enhancements should be prioritized in operational planning.

#### *4.5. Practical and policy implications*

The findings of this study offer several practical and policy implications for improving the effectiveness and sustainability of FPSs operating under the PDS. The results indicate that timely availability of goods, efficient stock management, and high-quality customer service are the most influential determinants of consumer satisfaction. Therefore, FPS operators should prioritize the maintenance of adequate inventory levels and adopt real-time stock monitoring systems to minimize stockouts and ensure the uninterrupted availability of essential commodities. Regular monitoring of inventory records and implementation of digital inventory management tools can significantly enhance service reliability and consumer trust.

The study also highlights the importance of staff training and customer service quality in improving operational efficiency. FPS managers should invest in periodic training programs aimed at enhancing employees' technical competencies, customer-handling skills, and awareness of government distribution policies. Such initiatives can improve service delivery standards, reduce operational errors, and strengthen consumer confidence in the system. Additionally, the adoption of performance evaluation mechanisms based on operational and service quality indicators can facilitate continuous improvement.

From a policy perspective, the strong influence of geographical factors, including proximity to customers, accessibility, and population density, suggests that location planning should be a key consideration in FPS allocation decisions. Policymakers should utilize demographic and geographic information systems (GIS)-based analyses to identify underserved areas and optimize the spatial distribution of FPS outlets. Establishing shops in locations that are easily accessible to beneficiaries can improve service utilization and reduce the time and transportation costs incurred by consumers.

The findings further support the need for greater digitalization within the Public Distribution System. Government agencies should strengthen electronic point-of-sale (e-POS) systems, integrate inventory tracking mechanisms, and enhance supply-chain monitoring to improve transparency and accountability. Such measures can help reduce leakages, improve stock visibility, and ensure that beneficiaries receive their entitled commodities in a timely manner.

Finally, the results emphasize the need for a consumer-centric approach to FPS management. Regular feedback mechanisms, grievance redressal systems, and periodic consumer satisfaction assessments should be incorporated into administrative practices. By aligning operational processes with consumer expectations and local demographic characteristics, policymakers and FPS administrators can improve service effectiveness, increase beneficiary satisfaction, and strengthen the overall performance of the Public Distribution System.

### **5. Conclusion**

The survey data analysis provides vital insights into respondents' demographics and the factors impacting consumer satisfaction and operational efficiency in FPS. The age distribution shows a plurality of individuals aged 41-45, and the gender split indicates a higher representation of males than females. The bulk of respondents were graduates, which may influence their attitudes and expectations of fair price retailers.

The study indicates that the speed of item availability, stock management, and service quality primarily influence consumer satisfaction. These factors together explain about 56% of the variation in consumer satisfaction. The statistical significance of these indicators demonstrates that they were effective in improving the customer experience. Also, the operational efficiency analysis indicates that inventory management, staff training, and

customer service quality were essential, accounting for about 8.1% of the variance in operational efficiency. Furthermore, the data shows that closeness to clients, accessibility, and population density have a significant impact on the performance of fair-price stores, accounting for around 80.5% of the variance. This emphasizes the importance of fair-price shops focusing on their geographical positioning and accessibility to improve operational efficiency.

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The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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