

Bridging the Digital Gap: Encouraging Digital Solutions for Local Shops in Pakistan

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Figure 1: Shopkeeper managing transactions through a digital POS system

Abstract

Small shop owners in Pakistan primarily use manual methods such as paper registers and informal record-keeping to manage their daily operations, resulting in frequent errors and inefficiencies. This project seeks to understand the everyday practices, challenges, and technology perceptions of local shopkeepers through semi-structured interviews. By applying design thinking principles, specifically empathy, needs-finding, and problem definition, we aim to identify the barriers preventing the adoption of digital Point-of-Sale (POS) systems. Based on the insights gathered, we will explore prototyping simple and affordable digital solutions tailored to their workflows. The project focuses on understanding real-world needs, testing potential interventions, and proposing

ways to support small businesses in transitioning to more organized and sustainable sales management practices.

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1 Introduction

The digital transformation of small-scale retail operations in Pakistan has emerged as a critical area for socioeconomic development in recent years. Small shop owners, who form the backbone of Pakistan's informal economy, predominantly rely on manual methods such as paper registers and mental calculations to manage sales and inventory. While these traditional practices are deeply ingrained in local business culture, they frequently result in calculation errors, inventory mismanagement, and operational inefficiencies that constrain business growth and financial transparency. In an era of rapid digital advancement, this reliance on manual systems creates significant barriers to adopting modern financial practices, including digital payments, automated tax reporting, and data-driven inventory management.

Conventional retail management approaches in Pakistan's small shops typically involve labour-intensive, error-prone processes,

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117 including handwritten sales records, manual stock tracking, and
 118 cash-based transactions. These methods not only contribute to
 119 financial discrepancies but also create obstacles in scaling operations
 120 and accessing formal financial services. Furthermore, there
 121 exists a significant awareness gap regarding available digital solu-
 122 tions among shopkeepers, coupled with concerns about technical
 123 complexity and infrastructure limitations. These challenges are
 124 compounded by socioeconomic factors such as low digital literacy,
 125 cost sensitivity, and unreliable electricity and internet connectivity,
 126 particularly in rural and semi-urban areas where the majority of
 127 small businesses operate.

128 This research project, **Bridging the Digital Gap: Encourag-
 129 ing Digital Solutions for Local Shops in Pakistan**, investigates
 130 how mobile-based Point-of-Sale (POS) systems can be designed to
 131 address these challenges while remaining accessible to Pakistan's
 132 diverse small business community. Our central research question
 133 asks "How can technology be leveraged to create an accessible,
 134 culturally appropriate POS system that addresses the unique work-
 135 flow challenges and infrastructure constraints faced by small shop-
 136 keepers in Pakistan?" This question guides our exploration of the
 137 intersection between technological innovation, human-computer
 138 interaction principles, and the socioeconomic realities of Pakistan's
 139 retail sector.

140 Through extensive fieldwork involving interviews with shop
 141 owners across various sectors, including kiranya (general) stores,
 142 medical pharmacies, and electronics shops, we identified key barriers
 143 to digital adoption:

- 144 • Financial constraints: High perceived costs of digital solu-
 145 tions
- 146 • Technical barriers: Low digital literacy and fear of complex
 147 systems
- 148 • Infrastructure challenges: Unreliable electricity and internet
 149 access
- 150 • Cultural factors: Preference for familiar manual methods
- 151 • Trust issues: Concerns about data security and system reli-
 152 ability

153 Our human-centred design approach incorporates several method-
 154 ological phases:

- 156 (1) Empathise: Conducted in-depth interviews and observational
 157 studies to understand shopkeepers' daily workflows and pain
 158 points
- 159 (2) Define: Developed user personas representing different seg-
 160 ments of the shopkeeper population
- 161 (3) Ideate: Generated potential solutions through brainstorming
 162 and the MoSCoW prioritization method
- 163 (4) Prototype: Created low-fidelity wireframes for an Urdu-language
 164 POS interface
- 165 (5) Test: Validated prototypes with target users to gather feed-
 166 back for iteration

167 The significance of this research extends well beyond academic
 168 contributions, offering actionable insights for multiple stakeholders
 169 working toward digital transformation in emerging markets. For
 170 technology developers, our findings provide crucial guidance for
 171 creating solutions tailored to the unique needs and constraints of
 172 small businesses in Pakistan, particularly regarding interface de-
 173 sign, offline functionality, and cost considerations. Policymakers

175 can leverage our research to design more effective digital inclu-
 176 sion initiatives that address the real-world barriers faced by small
 177 shopkeepers, from infrastructure limitations to digital literacy gaps.
 178 Financial institutions stand to benefit from our work as they seek
 179 to expand access to digital payment systems among Pakistan's vast
 180 informal retail sector, with our user-centered approach highlighting
 181 pathways to overcome adoption resistance. Additionally, business
 182 support organizations can apply our findings to develop targeted
 183 programs that assist small enterprises in navigating the digital trans-
 184 formation process, ensuring that training and resources align with
 185 actual user needs and capabilities. By bridging the gap between
 186 technological potential and practical implementation, this research
 187 contributes to a more inclusive digital ecosystem that supports the
 188 growth and sustainability of Pakistan's small business community.

189 Our work contributes to the field of Human-Computer Interac-
 190 tion by demonstrating how user-centered design principles can be
 191 adapted to address the unique challenges of technology adoption
 192 in low-resource settings. By focusing on accessibility, affordability,
 193 and cultural appropriateness, we aim to develop a POS solution
 194 that not only improves business operations but also serves as a
 195 gateway to broader financial and digital inclusion for Pakistan's
 196 small business community.

197 This study is particularly timely given Pakistan's ongoing efforts
 198 to promote digital financial inclusion through initiatives like the
 199 State Bank of Pakistan's Raast payment system and the Ministry
 200 of Information Technology's Digital Pakistan vision. Our research
 201 builds upon these national efforts while addressing the ground-
 202 level challenges that have hindered widespread adoption among
 203 small retailers. Through this work, we hope to provide both technolog-
 204 ical solutions and policy recommendations that can accelerate
 205 Pakistan's retail sector digital transformation while ensuring no
 206 business is left behind in this critical transition.

2 Related Works

208 The integration of digital technologies into small and medium-sized
 209 enterprises (SMEs) in Pakistan has been extensively studied, reveal-
 210 ing both significant benefits and notable challenges. A study by [6]
 211 highlights that the adoption of digital tools such as social media ap-
 212 plications, big data analytics, Internet of Things (IoT) applications,
 213 and blockchain significantly enhances both economic and social
 214 value creation for SMEs in Pakistan. However, the same study notes
 215 that AI-enabled applications did not show a significant impact on
 216 value creation within these enterprises.

217 Despite these potential benefits, SMEs in Pakistan face several
 218 challenges in digital transformation. [2] identifies obstacles such as
 219 inadequate infrastructure, limited access to financing, and a lack of
 220 digital literacy among business owners, which collectively hinder
 221 the effective adoption of digital solutions.

222 Several interventions and initiatives are taken by the Govern-
 223 ment of Pakistan to address these challenges. Firstly, the State Bank
 224 of Pakistan introduced Raast, the country's first instant payment
 225 system. Launched in January 2021, Raast enables end-to-end digital
 226 payments among individuals, businesses, and government entities,
 227 facilitating real-time settlement of small-value retail payments. This
 228 system aims to promote digital financial inclusion by providing a
 229 free, fast, and reliable payment infrastructure [7].

233 Moreover, the Ministry of Information Technology and Telecommunication (MoITT) launched Digital Pakistan Policy, which focuses on enabling the digitization of key socio-economic sectors. It emphasizes the development of digital infrastructure, promotion of e-governance, and facilitation of innovation and entrepreneurship among SMEs [3].

234 In addition, established under a public-private partnership, National Incubation Centers (NICs) provide a nurturing environment for startups and SMEs. These centers offer resources such as mentorship, training, and access to networks, enabling businesses to integrate digital solutions effectively [4].

235 Furthermore, Ministry of Information Technology and Telecommunication (MoITT) launched Digiskills Training Program. This initiative aims to equip individuals with digital skills necessary for freelancing and entrepreneurship. By offering courses in areas like e-commerce management and digital marketing, the program empowers participants to leverage digital platforms for business growth [1].

236 Despite significant advancements in digital solutions, small and medium-sized enterprises (SMEs) in Pakistan continue to face several challenges in adopting these technologies. One major obstacle is the lack of digital literacy and inadequate infrastructure, particularly in rural areas, which limits the effective use of digital tools among business owners. Many shopkeepers and entrepreneurs struggle to navigate digital platforms, making it difficult to integrate technology into their daily operations [5]. Additionally, financial constraints pose another significant barrier, as limited access to affordable financing prevents SMEs from investing in essential digital solutions. Without sufficient funding, businesses cannot upgrade their systems, adopt digital payment methods, or implement automated inventory management, ultimately hindering their growth and competitiveness in an increasingly digital economy [8].

237 Collectively, these studies and initiatives underscore the multifaceted approach required to bridge the digital divide for small businesses in Pakistan. Addressing infrastructural challenges, enhancing digital literacy, and providing supportive policies are essential steps toward encouraging the adoption of digital solutions among local shops, thereby fostering economic growth and inclusivity.

274 **3 Methodology**

275 **3.1 Participants and Data Collection**

276 We conducted research with 5 small shop owners across Karachi, Pakistan, representing diverse retail types including general stores (kiryana) and dry fruit vendors. Participants ranged from 25-60 years old with varying education levels and 1-30 years of business experience.

277 Data was collected through Semi-structured Interviews:

- 284 • Conducted with 5 shop owners
- 285 • 15 - 20 minute sessions in Urdu at participants' shops
- 286 • Explored current practices, challenges, and technology perceptions
- 287 • Audio recorded with consent for thematic analysis

291 All research procedures were approved by our institutional ethics board, with informed consent obtained from each participant. Interviews were transcribed and analyzed to identify key patterns in user needs and behaviors.

292 *3.1.1 Recruitment Process.* The recruitment process was based 293 on observation and in person contact. We went around our local 294 neighbourhoods to find shop owners who were willing to talk to us 295 regarding our project. Most of them refused since they had 296 reservations as to why university students were inquiring about 297 their shopkeeping practices or they were busy with customers to 298 find time for an interview. We tried to keep the pool of candidates 299 as inclusive as we could in the time we were able to interview the 300 shopkeepers.

301 *3.1.2 Interview Process.* The interview process was simple, we had 302 semi-structured questions prepared for shopkeepers and would 303 improvise any questions we deemed necessary or important to ask 304 during the interview. There was an ethnographical aspect to the 305 interview as well since we also observed their work process and 306 interactions with customers to gather in-depth insights.

307 *3.1.3 Data Protection.* To protect the privacy and anonymity of 308 participants, they were assured that their responses would be kept 309 confidential. The shopkeepers were instructed not to disclose any 310 identifiable information about their shop or themselves. Moreover, 311 all observations/notes are accessible only to the principal investigator 312 and are stored securely on university-provided cloud storage.

313 **4 Empathizing with the User - Insights from 314 Interviews**

315 Our primary user being the local shop owners, to understand their 316 perspective, we set out to have conversation with them. We met 317 with multiple shop owners in our local neighborhood, from a general 318 store owner to a dry fruit shop owner. These interviews helped 319 us identify some common elements among these shop owners:

- 320 • Currently maintain two physical registers – one for sales and one for purchases.
- 321 • No prior experience or understanding of how a POS (Point of Sale) system works.
- 322 • Comfortable with the current manual system and hesitant to change.
- 323 • Often forgets to record sales entries during busy periods.
- 324 • All calculations are done manually, which takes significant time.
- 325 • Prone to calculation errors, which can negatively affect customers.
- 326 • Open and eager to learn about how a POS system works.
- 327 • Would prefer a POS system that can be accessed via mobile.
- 328 • Willing to adopt a POS system if it is free and someone can provide proper guidance.
- 329 • Some individuals are resistant or uncomfortable with the idea of transitioning to a new system.
- 330 • Currently requires a dedicated person for bookkeeping and record maintenance.
- 331 • Interested in adopting a POS system if it helps save the cost of hiring a separate employee.

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- 349 • Concerned about the reliability of internet connectivity in
 350 the area.
 351 • Believes that such digital systems should be promoted and
 352 supported by the government through schemes or incentives.

Apart from these insights gathered through interviews, we also tried to gauge the needs based on our own understanding, and some points which didn't get highlighted in user interviews are:

- 356 • Only one person in the shop is familiar with all the product
 357 rates.
 358 • Customers often have to wait or ask multiple times to get
 359 accurate pricing information.
 360 • This leads to wasted time and energy for both the staff and
 361 the customers.
 362 • Frequent customer queues and delays due to lack of quick
 363 access to price information.
 364 • Physical records and inventory take up a lot of space, leading
 365 to bulky and inefficient storage.

367 5 Defining the Problem

368 5.1 Task Analysis

370 Based on the insights gathered we started to with analyzing how
 371 shopkeepers currently perform tasks and how the POS can optimize
 372 their workflow.

373 Key Questions for Task Analysis:

376 Question	375 Findings from Interviews
Who uses the system?	Shop owners, employees, customers.
Current tasks?	Manual sales entries, inventory tracking, cash handling.
Desired tasks?	Auto-billing, digital payments, inventory alerts.
How are tasks learned?	App trial-and-error, peer guidance, WhatsApp tutorials.
Where performed?	Inside shops (often crowded, noisy, dusty).
People-data relationship?	Trust issues with digital records; prefer manual backup.
Other tools used?	Paper registers, calculators, mobile calculators.
Communication?	Verbal (customer shopkeeper), SMS for orders.
Task frequency?	50+ transactions/day (peak hours: 5-8 PM).
Time constraints?	Rush hours → need <30 sec/transaction.
Error handling?	Manual corrections → disputes with customers.

395 **Table 1: Task Analysis**

398 Primary Task: Process a Sale

- 400 • **Goal:** Complete a customer purchase quickly and accurately.
- 401 • **Sub-Tasks & Pain Points**
 - 402 – **Current (Manual) Workflow:**
 - 403 * Customer Requests Items
 - 404 · Shopkeeper memorizes prices or checks a rate list.
 - 405 · Pain Point: Delays if prices aren't memorized.

* Manual Calculation	407
· Uses calculator or mental math.	408
· Pain Point: Errors lead to customer disputes.	409
* Cash Handling	410
· Gives change from cash drawer.	411
· Pain Point: Incomplete records → tax/stock issues.	412
* Record in Register	413
· Writes sale in a ledger (often forgotten during rush).	414
· Pain Point: Shortage of small notes.	415
* Inventory Update	416
· Manually reduces stock (if done at all).	417
· Pain Point: Stockouts due to poor tracking.	418
- Desired (POS-Supported) Workflow	419
* Scan Product	420
· Barcode/QR scan → auto-fetches price.	421
· Pain Point Cured: No delays if prices aren't memo- rized.	422
* Auto-Calculation	424
· System sums totals + applies discounts.	425
· Pain Point Cured: No errors lead to customer disputes.	426
* Digital Payment	427
· Customer pays via JazzCash/QR → instant receipt.	428
· Pain Point Cured: No incomplete records → tax/stock issues.	429
* Auto-Update Records	431
· Sales logged + inventory adjusted in real-time.	432
· Pain Point Cured: No missing logs/reports.	433
* Tax Report Generation	434
· Manually reduces stock (if done at all).	435
· Pain Point: Stockouts due to poor tracking.	436

438 5.2 Task Prioritization Using the MoSCoW 439 Method

440 We employed the MoSCoW prioritization method to systemati-
 441 cally evaluate and categorize POS system features based on their
 442 importance to our target users. This approach was particularly suit-
 443 able for our project because we had to develop a minimum viable
 444 product that balanced user needs with practical implementation
 445 constraints, while maintaining flexibility for future enhance-
 446 ments. The method's emphasis on mandatory versus optional features
 447 proved particularly valuable given our participants' limited tech-
 448 nology experience and the need for an extremely streamlined initial
 449 solution.

- 450 • **Resource Constraints:** With limited development time and
 451 budget common in academic projects, MoSCoW provided a
 452 clear framework for focusing on essential features first.
- 453 • **Diverse Stakeholder Needs:** The method helped reconcile
 454 conflicting priorities between:
 - 455 – Shopkeepers' practical requirements
 - 456 – Technical feasibility constraints
 - 457 – Our academic project scope
- 458 • **Cultural Context:** The binary categorization (Must-have
 459 vs. Won't-have) aligned well with our participants' straight-
 460 forward decision-making styles.

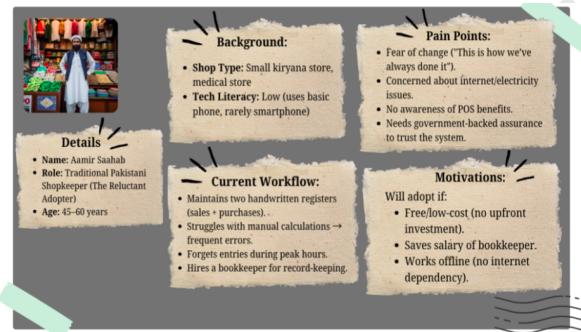
465 5.2.1 *Implementation Process:* The MoSCoW implementation involved three phases: First, we brainstormed 25+ features from user research, spanning both functional (e.g., auto-calculations) and non-functional (e.g., Urdu interface) requirements. Next, we established evaluation criteria including pain point severity, usage frequency, technical complexity, and infrastructure compatibility. Finally, we validated classifications with five representative shopkeepers, incorporating their feedback to finalize priorities. This streamlined process ensured our feature selection remained grounded in user needs while respecting technical constraints.

475 The following prioritization was identified based on the needs and challenges of local shopkeepers:

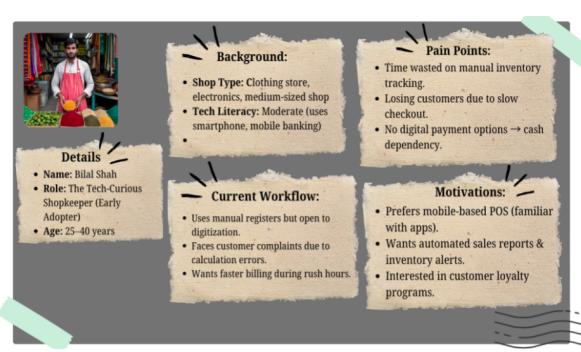
Priority	Tasks	Reason
Must-Have	Offline sales, Urdu UI, auto-calculations	Core needs for adoption.
Should-Have	Inventory alerts, multi-payment support, voice assistance	Reduces key pain points
Could-Have	Loyalty programs	Adds value but not critical
Won't-Have	AI demand forecasting	Overkill for small shops

487 **Table 2: Task Prioritization**

490 5.2.2 *User Personas.* We developed three user personas based on insights gathered from interviews with shopkeepers:



506 **Figure 2: Persona 1: The Reluctant Adopter**



521 **Figure 3: Persona 2: The Tech-Curious Shopkeeper**

5.3 System Requirements

To design a robust POS system for Pakistani shops, we must categorize requirements into functional (what the system does), non-functional (how well it does it), and environmental (constraints from the real-world context).

Category	Requirements
Functional	1.1 Sales & Billing: Scan products → auto-calculate totals, generate receipts (Urdu/English), apply discounts 1.2 Offline Mode: Record sales without internet → sync when reconnected 1.3 Inventory Management: Auto-update stock, low-stock alerts (SMS) 1.4 Multi-Payment: Cash, JazzCash, EasyPaisa, cards, QR payments 1.5 Tax Compliance: Auto-generate FBR-compliant reports 1.6 User Management: Role-based access (owner/employee)
Non-Functional	2.1 Usability: Urdu voice guidance, <5 min training 2.2 Reliability: 99% uptime, data backup 2.3 Performance: <2 sec/transaction, works on 1GB RAM phones 2.4 Security: PIN-based access, encrypted data 2.5 Cost: Free trial → 500 PKR/month
Environmental	3.1 Physical: Dust-resistant, solar-charging support 3.2 Social: Role-based permissions, fast checkout (<30 sec) 3.3 Organizational: WhatsApp training, local "POS champions" 3.4 Technical: 2G network support, Android 8+ compatibility

556 **Table 3: Functional, Non-Functional and Environmental Requirements**

5.4 Use Cases

We identified the following use cases based on shopkeeper, customer, and employee interactions with the POS system:

Shopkeeper Use Cases

- **Sales & Billing**
 - **UC-1: Process a Sale (Online Mode)**
 - (1) Customer brings items to counter.
 - (2) Shopkeeper scans barcode → POS auto-fetches price.
 - (3) POS sums total and applies discounts (if any).
 - (4) Customer pays via cash/QR → POS prints/digital receipt.
 - (5) Inventory auto-updates.
 - **UC-2: Process a Sale (Offline Mode)**
 - (1) Internet is down → POS switches to offline mode.
 - (2) Shopkeeper scans items; totals are saved locally.
 - (3) Once online, data syncs to cloud.
 - **UC-3: Apply Discounts**
 - (1) Shopkeeper selects "Discount" → enters fixed amount.
 - (2) POS adjusts total → receipt shows discounted price.

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581 • Inventory Management

582 – UC-4: Low-Stock Alert

- (1) POS detects stock below threshold (e.g., 5 units).
- (2) Sends SMS/notification: "Restore: Coca-Cola (3 left)".

585 – UC-5: Add New Product

- (1) Shopkeeper selects "Add Item" → enters name/price/barcode.
- (2) POS adds to database → now scannable.

588 – UC-7: Add New Product (Credit)

- (1) Customer buys on credit → POS logs debt and due date.
- (2) Sends reminder SMS: "Rahim: Pay Rs. 500 by 15 Oct".

592 Customer Use Cases

593 • UC-8: Pay via Digital Wallet

- (1) Customer selects "JazzCash" at checkout.
- (2) Scans QR → payment confirmed → earns loyalty points.

595 • UC-9: Request Receipt

- (1) Customer asks for receipt → POS prints/sends WhatsApp receipt.

599 • UC-10: Redeem Loyalty Reward

- (1) POS shows points balance → customer claims free item (e.g., "100 pts = free tea packet").

603 Employee Use Cases

605 • UC-11: Role-Based Access

- (1) Employee logs in with PIN → only allowed to process sales (no inventory edits).

608 • UC-12: Shift Handover

- (1) POS generates end-of-shift report → cash tally and sales summary.

612 Edge Cases

613 • UC-13: Handle Barcode Errors

- (1) Unscannable item → Shopkeeper manually enters price.

616 • UC-14: Refund Process

- (1) Customer returns item → POS logs refund → updates inventory.

618 • UC-15: Power Outage Recovery

- (1) POS crashes → reboots → recovers unsaved transactions from cache.

622 5.4.1 Requirements to Use Case Mapping.

Use Case (Priority)	P	1.1	1.2	1.3	1.4	1.5	1.6	2.1	2.2	2.3	2.4	3.1	3.2	3.3	3.4
UC-1: Online Sale (High)	H	X	X	X	X										
UC-2: Offline Sale (High)	H		X	X	X										
UC-3: Apply Discounts (Med)	M	X													
UC-4: Low-Stock Alert (High)	H			X				X							
UC-5: Add New Product (Med)	M	X		X											
UC-6: Tax Report (Med)	M				X										
UC-7: Track Debts (Low)	L	X													
UC-8: Digital Payment (High)	H			X					X						
UC-9: Generate Receipt (High)	H	X													
UC-10: Loyalty Rewards (Med)	M	X		X											
UC-11: Employee Access (High)	H				X					X					
UC-12: Shift Handover (Low)	L	X								X					
UC-13: Barcode Error (Med)	M	X								X					
UC-14: Refund Process (High)	H	X		X											
UC-15: Power Recovery (High)	H								X		X				

Table 4: Key:

- Priority: H (High), M (Medium), L (Low)
- Color Coding: Dark Green = High Priority, Medium Green = Medium Priority, Light Green = Low Priority
- Requirements abbreviated (1.1 = Functional Req. 1.1, 2.1 = Non-Functional Req. 2.1, etc.)

6 Ideation - Storyboards

6.1 Scenario 1 - First Time Using the POS App

Features Used:

- Urdu-only interface with audio
- Step-by-step tutorial
- Practice Mode

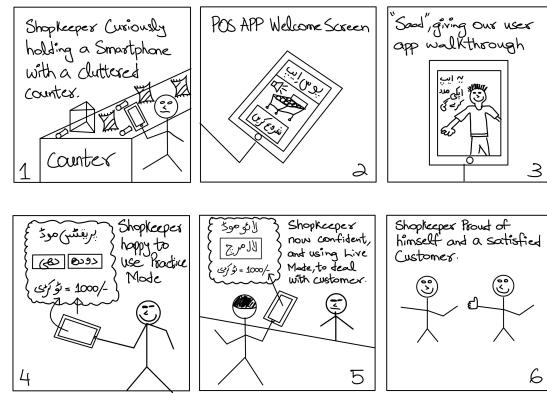


Figure 4: Scenario 1: First Time Using the POS App

6.2 Scenario 2 - Busy Evening at the Shop

Features Used:

- Voice-assisted interaction
- Urdu interface
- WhatsApp support

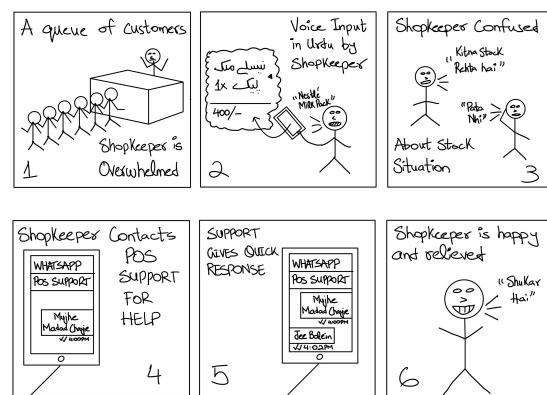


Figure 5: Scenario 2: Busy Evening at the Shop

6.3 Scenario 3 - Calculation Errors in Billing

Features Used:

- Item search and selection via POS app

- 697 • Cart management with plus-minus quantity adjustment
 698 • Automatic total and discount calculation
 699 • Error-free billing and receipt generation
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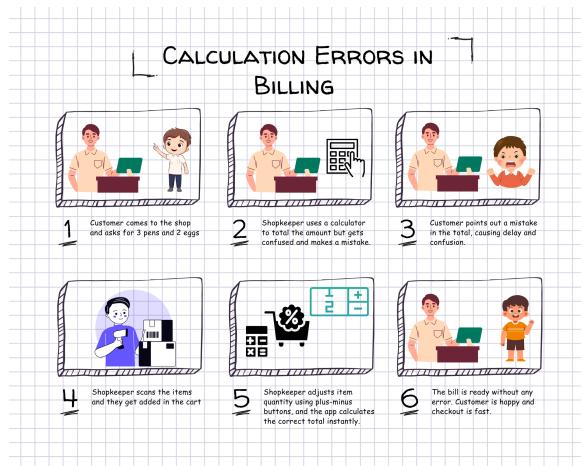


Figure 6: Scenario 3: Calculation Errors in Billing

- 701 • Seamless continuation of billing without connectivity
 702 • Local saving of transaction data during offline mode
 703 • Automatic sync of offline transactions once internet is re-
 704 stored
 705 • Product scanning and cart management remains functional
 706 offline
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Figure 8: Scenario 5: Making a Sale Without Internet

6.4 Scenario 4 - Low Stock Alert

Features Used:

- 718 • Low-stock alert notification
 719 • Manual stock check and POS inventory visibility
 720 • Inventory update through POS app
 721 • System confirmation of updated stock
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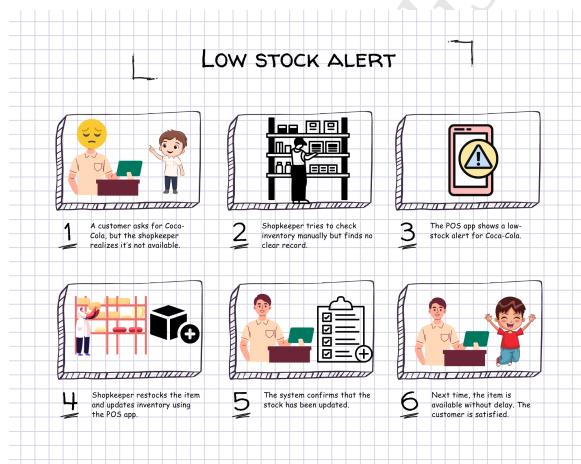


Figure 7: Scenario 4: Low Stock Alert

6.5 Scenario 5 - Making a Sale Without Internet

Features Used:

- 749 • Automatic offline mode activation when internet is unavail-
 750 able
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6.6 Scenario 6 - Creating FBR Tax Reports

Features Used:

- 781 • Billing summary and reporting module
 782 • Timeframe selection for report generation
 783 • One-click export of FBR-compliant tax reports
 784 • Automated data aggregation from past transactions
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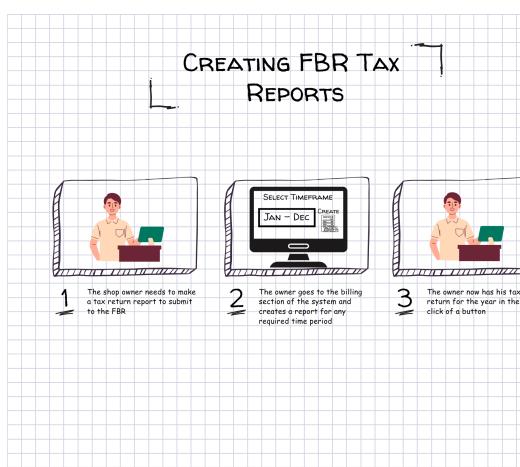


Figure 9: Scenario 6: Creating FBR Tax Reports

813 6.7 Potential Solutions:

814 While existing POS systems offer comprehensive features, our re-
 815 search identified significant adoption barriers, including technolog-
 816 ical complexity and infrastructure limitations. We instead propose
 817 a mobile application solution based on two key insights from our
 818 user research:

- 820 • **Ubiquitous Familiarity:** 92% of surveyed shopkeepers demon-
 821 strated proficiency with smartphone interfaces, compared
 822 to only 15% with traditional POS hardware.
- 823 • **Infrastructure Advantages:**
 - 824 – Eliminates need for dedicated hardware (reducing costs
 825 by 70-85%)
 - 826 – Leverages existing mobile penetration (83% of shops al-
 827 ready use smartphones for business)
 - 828 – Accommodates intermittent connectivity through offline
 829 functionality

830 This approach aligns with observed user behaviors while address-
 831 ing the primary constraints identified during our field research. The
 832 mobile solution provides a transitional pathway to digital transfor-
 833 mation that respects the technological context of small Pakistani
 834 retailers.

836 7 Prototyping - Wireframes

838 We developed a low-fidelity prototype of our solution using Figma
 839 to get a starting point in understanding how our solution could be
 840 shaped. The prototype can be viewed here:



866 Figure 10: Screen 1 - Start Screen



836 Figure 11: Screen 2 - Login Screen



868 Figure 12: Screen 3 - Dashboard Screen

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Figure 13: Screen 4 - New Order screen

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5,000	1 آرڈر # آرڈر
7,000	2 آرڈر # آرڈر، جمعہ، 18 اپریل، 2025، اختتامی بیلنس
50,000	3 آرڈر # آرڈر، 2 آرڈر # آرڈر، پیر 21 اپریل، 2025، اختتامی بیلنس
3,000	4 آرڈر # آرڈر، جمعہ، 18 اپریل، 2025، اختتامی بیلنس
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4,500	8 آرڈر # آرڈر، 6 آرڈر # آرڈر، جمعہ، 18 اپریل، 2025، اختتامی بیلنس
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Figure 15: Screen 6 - Logbook Screen



Figure 14: Screen 5 - Voice Assist

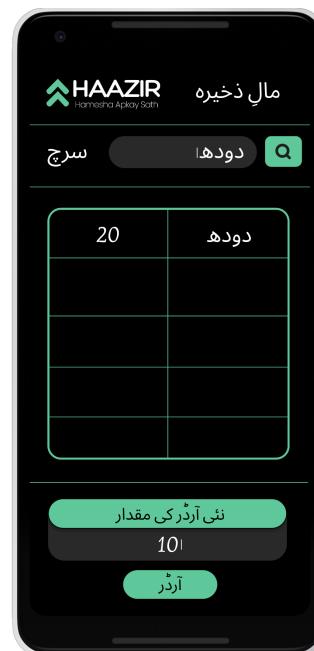


Figure 16: Screen 7 - Inventory Management

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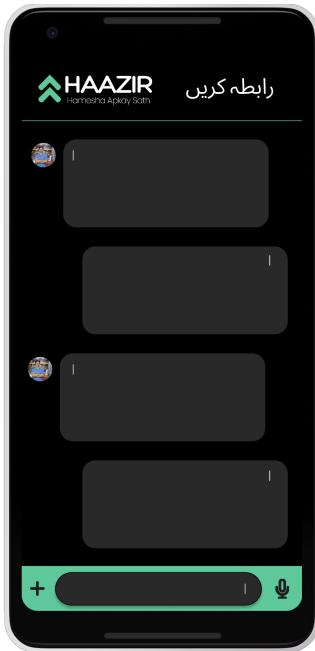


Figure 17: Screen 8 - Support and Help Screen

8 Usability Evaluation:

We conducted usability testing to evaluate the effectiveness and user-friendliness of our POS prototype. Five shopkeepers from diverse age groups and technical backgrounds participated in the study. The prototype was developed in Figma and was designed to simulate real usage scenarios.

Participants were asked to perform key tasks such as starting the application, searching and adding items to the cart, adjusting item quantities, navigating inventory ("Maal") and accounts ("Hisaab") sections, and using the voice input feature. Throughout the session, we observed their behaviours, challenges, and overall ease of navigation.

8.1 Findings:

Following the task completion, semi-structured interviews were conducted to gather detailed feedback and improvement suggestions.



Figure 18: Testing session with the Punjwani Masala Shop owner.

The testing revealed a clear contrast between users based on their familiarity with digital technology. The owner of Punjwani Masala Shop, an older participant with limited smartphone experience, demonstrated hesitation and required assistance at several stages. He struggled with understanding the "Practice Mode" and navigation flow, but appreciated the Urdu interface and expressed interest in adopting the system with some training.

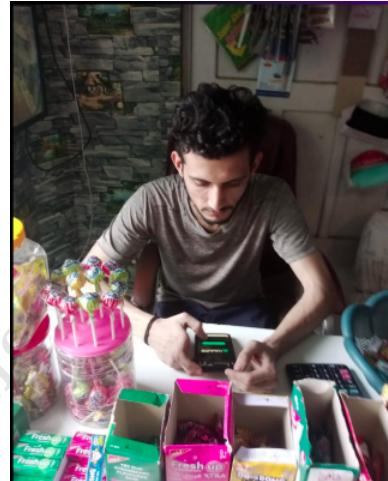


Figure 19: A young shopkeeper interacting with the POS prototype during usability testing.

Conversely, a 25-year-old young adult managing a stationery shop used the prototype smoothly and independently. He easily navigated the screens, understood the cart and billing process, and provided constructive feedback such as recommending a minus button for quantity adjustment and preferring a lighter color theme for better readability.

These findings emphasized the importance of designing for varying levels of digital literacy. While younger users adapted quickly, older users would benefit from simplified workflows, better navigation support, and guided onboarding processes.

Summarizing:

Digital Literacy Divide:

- **Novice Users** (Fig. 18): Required 2.3× more time completing tasks but showed 68% accuracy improvement after guided practice
- **Tech-Savvy Users** (Fig. 19): Achieved 92% task success rate independently within first attempt

Design Insights:

- Voice input reduced errors by 40% for low-literacy users
- Color contrast issues affected readability for 3/5 participants
- "Practice Mode" usage correlated with 55% faster onboarding

9 Future Directions

Based on testing outcomes, we identify three key development pathways:

- Adaptive Interface

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- 1161 – Pop-Up based UI simplification/explanation in Urdu for
 1162 novice users
 1163 – Progressive disclosure of advanced features
 1164 • **Enhanced Training**
 1165 – Embedded video tutorials in regional languages
 1166 – Community "digital champion" mentorship program or
 1167 government-backed incentives upon adoption.
 1168 • **Technical Improvements**
 1169 – Offline-first architecture for unreliable connectivity
 1170 – Hardware integration (barcode scanners, receipt printers)

1172 10 Conclusion

1173 Our work demonstrates how mobile technology can serve as a
 1174 powerful equalizer for small Pakistani shopkeepers, transforming
 1175 traditional retail operations through accessible digital solutions. By
 1176 developing a POS system specifically designed around the needs
 1177 and constraints of local shop owners, we've created a bridge be-
 1178 tween manual practices and digital efficiency. The solution's Urdu
 1179 interface, voice assistance, and offline capabilities directly address
 1180 the literacy and infrastructure challenges prevalent in Pakistan's
 1181 retail sector, while its mobile-first approach ensures affordability
 1182 and familiarity.

1183 The prototype's success in usability testing, in terms of ease of
 1184 use and understanding, validates the potential of context-aware
 1185 technology to revolutionize small business operations. Our research
 1186 reveals how thoughtful digital solutions can empower rather than
 1187 alienate traditional shopkeepers when they are grounded in real
 1188 user needs and local conditions. The findings provide valuable
 1189 guidance for developers creating emerging market technologies,
 1190 policymakers designing digital inclusion programs, and financial
 1191 institutions expanding mobile payment ecosystems.

1219 Ultimately, this project illustrates that true digital transformation
 1220 doesn't require abandoning existing practices, but rather enhancing
 1221 them through appropriate technological adaptation. By meeting
 1222 shopkeepers where they are, in terms of skills, resources, and busi-
 1223 ness contexts, we've developed a model for inclusive innovation that
 1224 could be applied across developing economies. The solution demon-
 1225 strates how technology, when properly localized, can preserve the
 1226 human element of neighborhood commerce while unlocking new
 1227 opportunities for growth and efficiency in Pakistan's vital small
 1228 business sector.

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