

PERFORMANCE TESTING & QUALITY ASSURANCE

To Supply Leftover Food to Poor - Comprehensive Testing Framework

Project Testing Phase: Performance Testing & Quality Assurance

Date: November 1, 2025

Team ID: NM2025TMID08527

Project Name: To Supply Leftover Food to Poor

Maximum Marks: 4 Marks

PERFORMANCE TESTING OBJECTIVES

Primary Testing Goals:

- **Functionality Verification:** Ensure all system components (collection, storage, distribution, tracking) function correctly under operational conditions
- **Performance Under Load:** Verify system maintains acceptable performance as volume scales from 500 to 3,000 daily meals with responsive user interfaces
- **Food Safety Assurance:** Validate that cold chain temperature monitoring, documentation, and verification procedures prevent food safety incidents
- **Operational Efficiency:** Measure and verify that target efficiency metrics are achieved (15-20 min per collection, <\$1.50 per meal cost)
- **Volunteer Experience:** Confirm mobile app and volunteer coordination systems are intuitive, reliable, and enable efficient work
- **Data Integrity:** Verify complete and accurate traceability from donor through beneficiary with no data loss
- **Regulatory Compliance:** Ensure all FSSAI requirements, documentation standards, and audit procedures are properly implemented
- **Environmental Impact Accuracy:** Validate that CO2, water, and resource conservation calculations are accurate and verifiable
- **Financial Model Validation:** Confirm cost projections and revenue forecasts align with actual operational performance
- **Scalability Readiness:** Demonstrate system capability to scale to 3,000+ meals daily with current infrastructure and processes

TESTING SCOPE & COVERAGE

Phase 1: Foundation Testing (Months 1-3)

Scope: Pilot operations with 20-50 meals daily

Testing Areas:

1. Collection Process Testing

- Volunteer ability to complete collection checklist (5-10 min target)
- Temperature measurement accuracy ($\pm 0.5^{\circ}\text{C}$)
- Photo documentation quality and consistency
- Donor information capture completeness
- Delivery time to hub (<30 min)

2. Storage & Handling Testing

- Refrigeration temperature maintenance (0-5°C target)
- Food segregation protocols followed
- Storage duration limits (max 3 days) implemented
- Labeling accuracy and completeness

3. Distribution Testing

- Beneficiary count accuracy
- Delivery time efficiency (target 15 min per endpoint)
- Beneficiary satisfaction feedback
- Return container cleaning procedures

4. Cost Tracking

- Per-meal cost calculation (\$2.50 baseline)
- Volunteer hour tracking
- Fuel and transportation cost monitoring
- Cold storage operational cost measurement

5. Volunteer Experience Testing

- Clarity of protocols and procedures
- Equipment functionality and ease of use
- Communication with coordinators
- Training adequacy and competency
- Volunteer satisfaction and retention

Testing Methods:

- ♦ Direct observation of 20+ pilot collections

- Volunteer interviews and feedback forms
- Cost data analysis and reconciliation
- Temperature log review and verification
- Beneficiary satisfaction surveys

Success Criteria:

- ✓ Collection process completed <25 min (vs. 20-30 target)
- ✓ Temperature maintained 0-5°C with zero excursions >2 hours
- ✓ 100% documentation completeness
- ✓ 90%+ beneficiary satisfaction
- ✓ Cost per meal <\$2.50
- ✓ Volunteer retention >70%

Phase 2: Operational Testing (Months 4-6)

Scope: Scaling from 50 to 500 daily meals

Testing Areas:

1. Infrastructure Performance

- Hub facility temperature stability under 500+ daily meal load
- Refrigeration system continuous operation (24/7)
- Vehicle GPS tracking accuracy and reliability
- Backup power system effectiveness during outages
- Water supply adequacy for cleaning procedures

2. Process Efficiency Testing

- Collection zone optimization (4-5 zones, 15-20 collections per zone)
- Route planning optimization reducing travel time
- Volunteer shift coordination efficiency
- Hub food processing throughput (meals/hour)
- Distribution route optimization

3. Cost Performance Testing

- Per-meal cost reduction from \$2.50 to \$1.50 target
- Labor cost per meal as volume increases
- Fuel efficiency per mile traveled
- Equipment utilization rates
- Waste reduction (food loss, spoilage)

4. Food Safety Scaling

- Temperature maintenance at 5x volume
- Documentation accuracy at scale (20+ daily transactions)
- FIFO rotation effectiveness
- Cross-contamination prevention procedures
- Incident tracking and response effectiveness

5. Volunteer Coordination

- Shift scheduling efficiency (coverage >90%)
- Communication clarity and timeliness
- Volunteer assignment optimization
- Team dynamics and conflict resolution
- Training reinforcement adequacy

Testing Methods:

- Daily operations monitoring and data collection
- Weekly efficiency analysis and optimization
- Cost tracking and variance analysis
- Temperature log trending and analysis
- Beneficiary and volunteer surveys (weekly)
- Hub manager observation and feedback

Success Criteria:

- ✓ Daily meals scaled to 500+ (vs. 100 in pilot)
- ✓ Cost per meal reduced to \$1.50 (40% reduction)
- ✓ Collection time <20 min per point
- ✓ Temperature compliance 100%
- ✓ Zero food safety incidents
- ✓ Beneficiary satisfaction >92%
- ✓ Volunteer utilization >85%

Phase 3: Compliance Testing (Months 7-9)

Scope: Formal food safety compliance verification

Testing Areas:

1. FSSAI Compliance Verification

- Documentation completeness and accuracy
- Temperature monitoring system functionality
- Staff certification status and validity

- Incident response protocol effectiveness
- Audit trail completeness and retrievability
- Facility inspection readiness

2. Food Safety System Testing

- Critical control point verification at each stage
- Temperature deviation detection and response
- Traceability system completeness (source to beneficiary)
- Incident logging and corrective action
- Cleaning and sanitation procedure verification

3. Staff Competency Testing

- Training completion certification (100%)
- Knowledge assessment scores (>80%)
- Practical skill demonstration
- Ongoing competency verification
- Annual refresher training completion

4. Incident Response Testing

- Simulated food safety incident response
- Root cause analysis documentation
- Corrective action implementation
- Effectiveness verification
- Communication with stakeholders

5. Audit Readiness

- Pre-audit inspection checklist completion
- Non-conformance identification and correction
- Documentation organization and accessibility
- Regulatory requirement verification

Testing Methods:

- Internal audit (comprehensive facility inspection)
- Mock regulatory inspection simulation
- Staff knowledge assessment tests
- Simulated incident response drills
- Document review and verification
- Beneficiary health/feedback monitoring

Success Criteria:

- ✓ All FSSAI requirements met
- ✓ Staff 100% trained and certified
- ✓ Zero critical non-conformances in pre-audit
- ✓ Complete documentation audit trail
- ✓ Incident response drills 100% successful
- ✓ Mock inspection zero findings
- ✓ Ready for official FSSAI audit

Phase 4: Technology Performance Testing (Months 10-15)

Scope: Mobile app, dashboard, and platform validation

Testing Areas:

1. Mobile App Performance

- Load time <3 seconds
- Offline functionality (collection checklist, navigation)
- GPS accuracy (± 10 meters)
- Battery consumption acceptable
- Crash rate <0.1%
- User interface intuitive (80%+ first-time success)

2. Dashboard Real-time Performance

- Map updates <5 second latency
- Inventory updates <10 second latency
- Temperature alerts <1 minute notification
- Analytics query response <2 seconds
- Report generation <30 seconds

3. API & Backend Performance

- Request response time <500ms (95th percentile)
- Database query response <100ms
- Concurrent user handling (100+ simultaneous)
- Data consistency verification
- Error handling and recovery
- Uptime 99.5% target validation

4. Data Migration & Integration

- Manual system data → Digital system migration
- Temperature log integration

- Beneficiary data accuracy
- Volunteer hour tracking accuracy
- Financial data reconciliation
- No data loss during migration

5. User Adoption & Satisfaction

- Volunteer app rating >4.2/5
- Donor portal usage >90%
- Dashboard administrator proficiency
- Support ticket resolution <24 hours
- User feedback implementation

6. Security Testing

- Authentication system robustness
- Data encryption verification
- Unauthorized access prevention
- SQL injection protection
- Cross-site scripting (XSS) prevention
- Penetration testing results

Testing Methods:

- Load testing (Apache JMeter) simulating 100+ concurrent users
- Mobile app testing on 10+ device types
- Network condition simulation (3G, 4G, WiFi)
- Battery consumption profiling
- API endpoint testing
- Security penetration testing
- User acceptance testing (UAT) with volunteers
- A/B testing of UI elements
- Analytics validation

Success Criteria:

- ✓ App load time <3 sec
- ✓ Dashboard latency <5 sec
- ✓ API response <500ms (95th percentile)
- ✓ Uptime 99.5%
- ✓ Volunteer adoption >80%
- ✓ Zero critical security issues

- ✓ User satisfaction >4.0/5
- ✓ Data migration 100% accurate

Phase 5: Scaling Performance Testing (Months 16+)

Scope: Multi-city operations validation

Testing Areas:

1. Multi-City Platform Performance

- System handles 10+ city databases simultaneously
- Inter-city reporting and analytics
- Central dashboard aggregates all cities
- Regional coordinator visibility
- Data isolation and security between cities

2. Replication Testing

- New city deployment time <5 days
- SOP documentation clarity and completeness
- Training effectiveness for new coordinators
- Technology platform deployment success
- Process adherence in new cities

3. Consistency Across Cities

- Cost per meal consistency (within 10% variance)
- Volunteer efficiency comparable
- Food safety compliance maintained
- Beneficiary satisfaction comparable
- Revenue model alignment

4. Scalability Under Volume

- System performance at 3,000 daily meals (4+ cities)
- Database performance with 100K+ records
- Dashboard rendering with multi-city data
- Alert system reliability at scale
- Backup and recovery procedures

5. Organizational Scaling

- Communication between cities effective
- Volunteer network coordination efficient
- Regional coordinator effectiveness

- Central team workload manageable
- Knowledge sharing across cities

Testing Methods:

- Pilot new city deployment with full monitoring
- Replication SOP verification in new cities
- Performance baseline comparison between cities
- Volume stress testing (3,000+ meals simulation)
- Organizational effectiveness surveys
- Cross-city communication testing

Success Criteria:

- ✓ New city deployment <5 days
- ✓ SOP adherence >95%
- ✓ Performance metrics within 10% variance between cities
- ✓ Cost consistency across locations
- ✓ System uptime 99.5% with multi-city load
- ✓ Volunteer coordination 90%+ effective

PERFORMANCE METRICS & KPIs

Operational Metrics

Metric	Phase 1 Target	Phase 2 Target	Phase 4 Target	Phase 5 Target
Daily Meals Collected	100	500+	1,000+	3,000+
Collection Time/Point	25 min	20 min	15 min	15 min
Cost per Meal	\$2.50	\$1.50	\$1.00	\$0.80
Volunteer Hours/100 meals	10	8	4.5	3
Beneficiary Satisfaction	85%	92%	95%+	95%+
Volunteer Retention	70%	85%	90%+	90%+
Food Safety Incidents	0	0	0	0

Technology Metrics

Metric	Target	Measurement
App Load Time	<3 sec	Device profiling
Dashboard Latency	<5 sec	Real-time monitoring

Metric	Target	Measurement
API Response Time	<500ms (95th)	APM tools
System Uptime	99.5%	Continuous monitoring
Mobile App Rating	>4.0/5	App store & surveys
User Adoption	>80%	Usage analytics
Crash Rate	<0.1%	Mobile analytics
Data Accuracy	99%+	Regular audits

Financial Metrics

Metric	Target	Validation
Revenue per Meal	\$0.40-0.60	Financial tracking
Cost per Meal	\$0.80-1.00	Cost analysis
Volunteer Hours Value	\$15-25/hour	Imputed labor
Operational Margin	20-30%	Monthly P&L
Cost of Goods Reduction	25%	Procurement analysis
ROI on Technology	8 months payback	Financial projection

Environmental Metrics

Metric	Target	Calculation
CO2 Prevented/Meal	2.3 kg	Waste × emission factor
Water Saved/Meal	1.0 liter	Food production water use
Land Conserved/Meal	0.005 m²	Agricultural land equivalent
Food Waste Diverted	5,000+ tonnes/year	Collection volume
GHG Equivalent	15M kg CO2-eq/year	Annual impact

QUALITY ASSURANCE PROCEDURES

Daily QA Checklist

Collection Process (Hub Manager - Morning):

- ☐ Review prior day's collection documentation
- ☐ Verify all temperature logs recorded
- ☐ Check for any incidents or deviations
- ☐ Confirm volunteer attendance and performance

- ☐ Inspect refrigeration equipment status
- ☐ Brief team on day's collection schedule

Hub Operations (Throughout Day):

- ☐ Monitor refrigeration temperature (4 readings daily)
- ☐ Record temperature in log with timestamp
- ☐ Visually inspect stored food for contamination
- ☐ Verify segregation maintained
- ☐ Check item labeling accuracy
- ☐ Monitor beneficiary delivery schedule adherence

Distribution Process (Evening - Hub Manager):

- ☐ Prepare meals for next day distribution
- ☐ Verify portion sizes and packaging
- ☐ Check labels for completeness (date, contents, expiry)
- ☐ Inspect container cleanliness
- ☐ Record distribution items and quantities
- ☐ Document any issues or feedback

End of Day:

- ☐ Reconcile collection vs. distribution quantities
- ☐ Calculate daily cost per meal
- ☐ Compile volunteer performance data
- ☐ Review beneficiary feedback
- ☐ Update operations log
- ☐ Flag any issues for management review

Weekly QA Audit

Conducted By: Designated QA Officer or Hub Manager

Verification Areas:

- ☐ Temperature log completeness (all readings)
- ☐ All incidents documented with resolution
- ☐ Staff training records current
- ☐ Volunteer hours accurately recorded
- ☐ Food safety protocols followed
- ☐ Documentation organized and accessible
- ☐ Equipment functioning properly

- ☐ Beneficiary feedback compilation

Output: Weekly QA Report with findings and corrective actions

Monthly Management Review

Conducted By: City Coordinator + Hub Manager

Analysis Areas:

- ☐ Cost per meal trend analysis
- ☐ Volunteer efficiency metrics
- ☐ Beneficiary satisfaction trending
- ☐ Food safety incident review
- ☐ Revenue vs. budget tracking
- ☐ Process improvement opportunities
- ☐ Technology system performance
- ☐ Staffing and capacity assessment

Output: Monthly Performance Report + Strategic Recommendations

Quarterly External Audit

Conducted By: External Food Safety Auditor

Scope:

- Complete facility inspection
- Staff competency assessment
- Documentation completeness review
- FSSAI compliance verification
- Non-conformance identification
- Corrective action tracking

Output: Audit Report + Certification (if compliant)

TEST CASE EXAMPLES

Test Case 1: Collection Process Validation

Objective: Verify collection procedure accuracy and completeness

Pre-conditions:

- Volunteer trained and certified
- Mobile app functional

- Donor food ready for pickup
- Collection containers prepared

Test Steps:

1. Volunteer receives notification of collection opportunity
2. Volunteer navigates to donor location using GPS
3. Upon arrival, verify donor food details
4. Conduct temperature measurement (should read $<5^{\circ}\text{C}$ or within 2-hour safe zone)
5. Perform visual inspection (no contamination, mold, pests)
6. Take photo of food items
7. Record quantity in app
8. Obtain donor digital signature
9. Pack into insulated containers with ice packs
10. Begin transport to hub (GPS tracking active)

Expected Results:

- ✓ Collection completed in <20 minutes
- ✓ Temperature accurately recorded
- ✓ Photo clearly shows food condition
- ✓ Quantity matches donor estimate
- ✓ Transport time <30 minutes
- ✓ Hub receives notification upon arrival

Test Case 2: Temperature Monitoring System

Objective: Verify continuous cold chain maintenance

Pre-conditions:

- Hub refrigeration operational
- Temperature monitoring devices calibrated
- Alert system functional

Test Steps:

1. Record baseline temperature ($0-5^{\circ}\text{C}$ target)
2. Monitor temperature every 6 hours for 24 hours
3. Simulate power outage (test backup generator)
4. Record generator operation and temperature maintenance
5. Restore main power and verify system recovery
6. Review temperature log for completeness

7. Generate alert if deviation detected

Expected Results:

- ✓ Temperature maintained 0-5°C throughout day
- ✓ Generator activates within 5 minutes of power loss
- ✓ Temperature maintained 0-5°C during backup power
- ✓ All readings recorded in log
- ✓ Alert triggered if temp >5°C for >2 hours
- ✓ Corrective action taken within 15 minutes

Test Case 3: Beneficiary Distribution Accuracy

Objective: Verify correct meals delivered to correct beneficiary with satisfaction

Pre-conditions:

- Meals prepared and packaged
- Distribution list verified
- Volunteer assigned
- Beneficiary endpoint informed

Test Steps:

1. Volunteer loads prepared meals into insulated containers
2. Navigate to first beneficiary endpoint
3. Verify endpoint location and contact person
4. Confirm meal count needed
5. Distribute meals with dignity
6. Record actual recipient count
7. Collect feedback (quality, quantity, satisfaction)
8. Confirm delivery completion in app
9. Proceed to next endpoint
10. Compile daily distribution report

Expected Results:

- ✓ Meals delivered to correct endpoint
- ✓ Quantity matches requirement
- ✓ Delivery time <15 minutes per endpoint
- ✓ Beneficiary satisfaction >90%
- ✓ All distributions documented
- ✓ Feedback recorded and compiled

PERFORMANCE BASELINES & TARGETS

Baseline (Phase 1 - Pilot)

Collection Volume:	100 meals/day
Cost per Meal:	\$2.50
Volunteer Hours/100m:	10 hours
Collection Time/Point:	25 minutes
Beneficiary Satisfaction:	85%
Food Safety Incidents:	0
System Uptime:	Not applicable (manual)

Phase 2 - Operational Target

Collection Volume:	500 meals/day
Cost per Meal:	\$1.50 (40% reduction)
Volunteer Hours/100m:	8 hours (20% improvement)
Collection Time/Point:	20 minutes (20% faster)
Beneficiary Satisfaction:	92%
Food Safety Incidents:	0 (continued)
System Uptime:	Not applicable (manual)

Phase 4 - Technology Target

Collection Volume:	3,000 meals/day
Cost per Meal:	\$1.00 (60% from baseline)
Volunteer Hours/100m:	4.5 hours (55% from baseline)
Collection Time/Point:	15 minutes (40% from baseline)
Beneficiary Satisfaction:	95%+
Food Safety Incidents:	0 (continued)
System Uptime:	99.5%
App Rating:	>4.0/5

Phase 5 - National Scale Target

Collection Volume:	40,000+ meals/week (10+ cities)
Cost per Meal:	\$0.80 (68% from baseline)
Volunteer Hours/100m:	3 hours (70% from baseline)
Collection Time/Point:	15 minutes (maintained)
Beneficiary Satisfaction:	95%+ (maintained)
Food Safety Incidents:	0 (sustained)
System Uptime:	99.5% (multi-city)
Operational Consistency:	±10% variance between cities

TEST EXECUTION SUMMARY

Phase-by-Phase Testing Timeline

Phase	Duration	Test Focus	Success Criteria	Go/No-Go
1	Month 1-3	Pilot operations, manual procedures	Zero incidents, 85%+ satisfaction	
2	Month 4-6	Operational scaling, efficiency	500 meals/day, \$1.50/meal	
3	Month 7-9	Compliance, documentation	FSSAI ready, zero findings	
4	Month 10-15	Technology, automation	3,000 meals, 99.5% uptime	
5	Month 16+	Multi-city scaling	10+ cities, consistency $\pm 10\%$	