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**BankIslami ATM Simulator - Detailed Test Results Documentation**

**1. Overview of Testing Process**

* **System Under Test**: BankIslami ATM Simulator
* **Database Used**: MySQL
* **Testing Methodologies Applied**:
  + **Functional Testing**: Verifying core features such as authentication, deposits, withdrawals, and MPIN management.
  + **Edge Case Testing**: Testing extreme cases such as withdrawal limits, incorrect MPIN formats, and database errors.
  + **Performance Testing**: Evaluating response times for transactions, login authentication, and balance inquiries.
* **Tools Used for Testing**: Manual Testing, MySQL Queries for database validation, and UI validation.
* **Scope of Testing**: Authentication, Deposits, Withdrawals, Fast Cash Transactions, MPIN Change, Balance Inquiry, Mini Statement.

**2. Detailed Test Cases & Results**

| **Test Case ID** | **Test Scenario** | **Expected Outcome** | **Actual Outcome** | **Status** |
| --- | --- | --- | --- | --- |
| TC-01 | Valid **Card Number & MPIN** | User successfully logs in | Login successful | Pass |
| TC-02 | Invalid **MPIN entry** | Authentication fails | Error message displayed | Pass |
| TC-03 | Valid deposit within **limit** | Deposit successful | Transaction recorded correctly | Pass |
| TC-04 | Withdrawal within **available balance** | Withdrawal processed successfully | Balance updated correctly | Pass |
| TC-05 | Withdrawal **exceeding balance** | Error message displayed | Insufficient balance alert triggered | Pass |
| TC-06 | Enter CNIC **with incorrect format** | Error message displayed | CNIC validation triggered correctly | Pass |
| TC-07 | Enter MPIN **less than 4 digits** | Error message displayed | MPIN validation works correctly | Pass |
| TC-08 | User selects **Fast Cash withdrawal** | Amount instantly deducted | Transaction recorded properly | Pass |
| TC-09 | Checking **Mini Statement** | Last 10 transactions displayed correctly | Transaction history displayed accurately | Pass |
| TC-10 | Checking **Balance Inquiry** | Current balance retrieved correctly | Correct balance displayed | Pass |
| TC-11 | Database failure while executing transaction | Error message shown | Connection error alert triggered | Failed |

**3. Bug Reports & Issues Encountered**

| **Bug ID** | **Module Affected** | **Description of Bug** | **Steps to Reproduce** | **Severity Level** | **Status** |
| --- | --- | --- | --- | --- | --- |
| BUG-001 | Login System | MPIN validation is case-sensitive, should be strictly numeric | Enter lowercase MPIN during login | Medium | Fixed |
| BUG-002 | Withdrawal | User is able to withdraw **PKR 0**, which should not be allowed | Enter 0 in withdrawal field and attempt transaction | High | Fixed |
| BUG-003 | Deposit | System allows deposit **above PKR 500,000** limit | Enter **600,000** as deposit amount | Critical | Fixed |
| BUG-004 | Balance Inquiry | Incorrect balance shown when multiple withdrawals processed quickly | Make multiple withdrawals consecutively | High | In Progress |
| BUG-005 | Transaction History | Mini-statement UI overlaps when displaying **more than 10 transactions** | Perform more than 10 transactions and check statement | Medium | Fixed |

**4. Edge Cases & Unexpected Behavior**

* **Fast Cash Withdrawal Limit Issue**: Initially, the system allowed users to withdraw more than **PKR 50,000** under the fast cash option. This was corrected by enforcing the withdrawal limit.
* **SQL Injection Vulnerability**: During testing, the MPIN field allowed non-numeric characters, which posed a security risk. Validation was improved to strictly enforce numeric MPINs.
* **Concurrency Issues**: When multiple withdrawals occurred simultaneously, balance calculations sometimes failed to update correctly. A proper synchronization mechanism is required.

**5. Performance Metrics**

| **Feature** | **Expected Response Time** | **Actual Response Time** |
| --- | --- | --- |
| **Login Authentication** | **<2 seconds** | **<2 seconds** |
| **Transaction Processing** | **<3 seconds** | **<3 seconds** |
| **Balance Inquiry Query Execution** | **<1 second** | **<1 second** |
| **Load Testing** | **Handles up to 1000 concurrent requests** | **Performance drops under high load** |

* Login, transaction processing, and balance inquiry operations performed within expected response times.
* The system struggles when handling a **high number of concurrent transactions (1000+ requests)**.
* Database indexing may improve efficiency in processing balance and transaction history retrieval.

**6. Summary & Recommendations**

**System Evaluation**

The **ATM Simulator functions correctly**, with authentication, deposits, withdrawals, MPIN changes, and balance inquiries all working as expected.  
**Database operations are secure**, preventing invalid inputs and enforcing strict validations.  
**Transaction history and mini-statement retrieval is functioning correctly**.

**Areas for Improvement**

**Performance Optimization**:

* System performance declines under heavy loads (**1000+ users simultaneously accessing transactions**).
* **Database indexing** can help optimize query execution times.
* **Asynchronous transaction processing** should be considered to prevent delays in balance updates.

**Concurrency Management**:

* Multiple withdrawals happening at the same time **sometimes show incorrect balance calculations**.
* A mechanism to **lock transactions** temporarily while balance updates are being processed should be implemented.

**Enhanced Error Handling**:

* When the database connection fails, the system should **retry connection before displaying an error**.
* Display **clear and informative error messages** instead of just generic database failure alerts.