

Requirements

1- Functional Requirements

| Ref. nr | Requirement | Description | Importance |
|---------|---|---|------------|
| FR-1.1 | The system must calculate routes between any two locations in Tirana and surrounding areas. | Provides optimal travel paths between origin and destination points. | Critical |
| FR-1.2 | The system must allow users to set preferences (fastest route, fewer transfers, lowest cost). | Enables personalization of journey planning based on user priorities. | High |
| FR-1.3 | The system must provide walking directions for first/last mile segments. | Guides users on foot travel to/from public transit stops. | Medium |
| FR-1.4 | The system must recalculate routes when disruptions occur. | Offers alternative paths during service interruptions. | High |
| FR-1.5 | The system must save user's favorite routes and destinations | Stores frequently used journeys for quick access | Medium |
| FR-2.1 | The system must show current location of all public transport vehicles on a map. | Displays real-time positioning of buses and other transit vehicles. | Critical |
| FR-2.2 | The system must display estimated arrival times at stops. | Provides countdown timers for next vehicle arrivals. | Critical |
| FR-2.3 | The system must show passenger density levels on vehicles. | Indicates crowding status to help users plan comfortable journeys. | Medium |
| FR-2.4 | The system must send notifications about service disruptions. | Alerts users to delays, cancellations, or route changes. | High |
| FR-2.5 | The system must provide a service status dashboard. | Offers overview of system-wide operational status. | Medium |
| FR-3.1 | The system must allow purchase of single, multi-journey, and subscription tickets. | Enables buying various ticket types directly in the app. | Critical |
| FR-3.2 | The system must generate QR codes for ticket validation. | Creates scannable proof of ticket purchase. | Critical |
| FR-3.3 | The system must support multiple payment methods. | Accommodates various ways to pay (credit cards, digital wallets, etc.). | High |
| FR-3.4 | The system must provide family/group ticketing options. | Allows purchasing multiple tickets in a single transaction. | Medium |
| FR-3.5 | The system must validate tickets at entry points. | Verifies ticket authenticity when boarding vehicles. | Critical |
| FR-3.6 | The system must issue receipts for all transactions. | Provides proof of payment for accounting purposes. | Medium |
| FR-4.1 | The system must allow users to create and manage accounts. | Enables personal profile creation and maintenance. | High |
| FR-4.2 | The system must store payment methods securely. | Protects financial information for future transactions. | Critical |
| FR-4.3 | The system must track journey history. | Records past trips for user reference. | Medium |
| FR-4.4 | The system must provide language options (Albanian, English, Italian). | Supports multiple languages for inclusive access. | High |
| FR-4.5 | The system must include accessibility features. | Ensures usability for people with disabilities. | High |
| FR-5.1 | The system must provide fleet monitoring for operators. | Offers administrators real-time vehicle tracking and management. | High |

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| FR-5.2 | The system must generate reports on passenger volumes and route performance. | Creates analytics for service optimization. | Medium |
| FR-5.3 | The system must allow operators to update service information. | Enables publishing schedule changes and service alerts. | High |
| FR-5.4 | The system must collect and organize user feedback. | Gathers input for service improvement. | Medium |
| FR-5.5 | The system must provide tools for transit planning. | Supports optimization of routes and schedules. | Medium |
| FR-6.1 | The system must provide APIs for third-party integration. | Allows external systems to connect with the platform. | Medium |
| FR-6.2 | The system must incorporate tourism information. | Includes points of interest for visitors. | Low |
| FR-6.3 | The system must include special event transportation data. | Provides transit options for concerts, sports, and other events. | Low |

The functional requirements for the Tirana public transportation app focus on route planning, real-time vehicle tracking, digital ticketing, and user account management. They also include tools for system operators and integration with external services. These features aim to enhance commuter experience and provide valuable insights to transit authorities. Additional needs like accessibility, multilingual support, and tourism information are also considered.

2-Non-functional requirements

The non-functional requirements for the Tirana public transportation app define how well the app should work, focusing on things like speed, security, ease of use, and compatibility with local conditions. They consider real-world limits such as weak internet in some areas, mobile battery use, and Albanian laws. These requirements help ensure the app is reliable, efficient, and ready to grow with future needs.

| Ref. nr | Requirement | Description | Type of requirement | Importance |
|----------------|---|--|------------------------------------|------------|
| NFR-1.1 | The system must support at least 400,000 concurrent users. | Ensures the system can handle the peak usage demands of Tirana's population. | Product - Efficiency - Performance | Critical |
| NFR-1.2 | The system must calculate routes in under 3 seconds. | Provides responsive user experience when planning journeys. | Product - Efficiency - Performance | High |
| NFR-1.3 | The system must maintain 99.9% uptime. | Guarantees service availability with minimal interruptions. | Product - Dependability | Critical |
| NFR-1.4 | The system must complete payment transactions in under 5 seconds. | Ensures efficient ticket purchasing experience. | Product - Efficiency - Performance | High |
| NFR-1.5 | The system must maintain location accuracy within 10 meters. | Provides precise positioning for navigation and vehicle tracking. | Product - Efficiency - Performance | High |
| NFR-2.1 | The system must encrypt all personal and payment data. | Protects sensitive user information from unauthorized access. | Product - Security | Critical |
| NFR-2.2 | The system must comply with GDPR and Albanian data protection laws. | Ensures legal compliance with relevant privacy regulations. | External - Legislative | Critical |
| NFR-2.3 | The system must implement secure authentication for admin access. | Prevents unauthorized system administration. | Product - Security | Critical |

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| NFR-2.4 | The system must time out sessions after 30 minutes of inactivity. | Reduces risk of unauthorized access to user accounts. | Product - Security | Medium |
| NFR-2.5 | The system must undergo regular security audits. | Maintains ongoing verification of security measures. | Organizational - Operational | High |
| NFR-3.1 | The system must be usable without training. | Ensures intuitive interface accessible to all user skill levels. | Product - Efficiency - Usability | High |
| NFR-3.2 | The system must meet WCAG 2.1 AA accessibility standards. | Makes the application usable for people with disabilities. | External - Ethical/Legislative | High |
| NFR-3.3 | The system must maintain consistent design across platforms. | Provides uniform experience on different devices. | Product - Efficiency - Usability | Medium |
| NFR-3.4 | The system must allow one-handed operation for essential functions. | Enables use while holding onto public transport supports. | Product - Efficiency - Usability | Medium |
| NFR-3.5 | The system must provide clear error messages. | Helps users understand and resolve issues. | Product - Efficiency - Usability | Medium |
| NFR-4.1 | The system must have maximum unplanned downtime of 1 hour per month. | Ensures service reliability with quantified availability targets. | Product - Dependability | Critical |
| NFR-4.2 | The system must implement automated backups. | Protects against data loss scenarios. | Product - Dependability | High |
| NFR-4.3 | The system must function with reduced connectivity. | Maintains operation in areas with poor network coverage. | Product - Dependability | High |
| NFR-4.4 | The system must provide core features when offline. | Enables basic functionality without internet connection. | Product - Dependability | High |
| NFR-5.1 | The system must handle 50% annual growth in users. | Accommodates increasing adoption without performance degradation. | Organizational - Development | Medium |
| NFR-5.2 | The system must support expansion to additional cities. | Allows geographic scaling of the service. | Organizational - Development | Low |
| NFR-5.3 | The system must accommodate new transportation modes. | Enables future integration of additional transit types. | Organizational - Development | Medium |
| NFR-6.1 | The system must use modular architecture. | Facilitates easier updates and component replacement. | Organizational - Development | Medium |
| NFR-6.2 | The system must include comprehensive logging. | Supports troubleshooting and system monitoring. | Organizational - Development | Medium |
| NFR-6.3 | The system must support configuration changes without redeployment. | Allows system adjustments without service interruption. | Organizational - Development | Medium |
| NFR-6.4 | The system must follow documented coding standards. | Ensures code quality and maintainability. | Organizational - Development | Medium |
| NFR-7.1 | Mobile apps must use no more than 5% battery per hour. | Minimizes power consumption on user devices. | Product - Environmental | High |

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| NFR-7.2 | The system must use energy-efficient infrastructure. | Reduces ecological footprint of backend systems. | Organizational - Environmental | Medium |
| NFR-8.1 | The system must complete installation in under 2 minutes on standard devices. | Ensures quick onboarding without frustration. | Product - Efficiency - Performance | Medium |
| NFR-9.1 | The system must comply with public transportation accessibility regulations. | Ensures legal compliance with transit laws. | External - Legislative | High |

3- Domain requirements

Domain requirements for the Tirana Public Transportation App represent critical constraints and conditions specific to the operational environment of public transportation in Tirana, Albania. These requirements arise from the unique characteristics of Tirana's infrastructure, transportation patterns, local regulations, and socioeconomic factors. Failure to properly address these domain-specific requirements could render the application ineffective or unusable within this specific context, regardless of its technical quality.

Key Domain Requirements

DR-1: Tirana Street Network

- **Description:** The app must accommodate Tirana's intricate street layout, characterized by narrow, one-way streets and informal transit stops.
- **Summary:** Route calculations should consider Tirana's unique street patterns and unofficial stops.
- **Importance:** High

DR-2: Mixed Transportation Fleet

- **Description:** The system should support various public transport modes in Tirana, including city buses and minibuses, each with distinct tracking and payment systems.
- **Summary:** Integrate diverse transport modes with their specific operational features.
- **Importance:** High

DR-3: Variable Traffic Conditions

- **Description:** The app must adapt to Tirana's fluctuating traffic patterns, influenced by peak hours, weekends, and special events.
- **Summary:** Incorporate real-time and historical traffic data for accurate arrival estimates.
- **Importance:** High

DR-4: Network Connectivity Limitations

- **Description:** Ensure core functionalities operate effectively despite inconsistent mobile network coverage in certain areas of Tirana.
- **Summary:** Design the app to function reliably even with intermittent connectivity.
- **Importance:** High

DR-5: Regional Payment Practices

- **Description:** The payment system should align with local preferences, supporting mobile payments, bank integrations, and cash alternatives, complying with Albanian regulations.
- **Summary:** Accommodate local payment methods and regulatory requirements.
- **Importance:** High

DR-6: Informal Transit Stops

- **Description:** Recognize and incorporate informal transit stops commonly used by locals but not officially documented.
- **Summary:** Include unofficial yet frequently used transit points in the app's routing.
- **Importance:** Medium

DR-7: Multilingual Support

- **Description:** Provide language options to cater to both Albanian residents and international visitors.
- **Summary:** Offer the app interface in multiple languages for broader accessibility.
- **Importance:** Medium

DR-8: Accessibility Features

- **Description:** Ensure the app is usable by individuals with disabilities, adhering to accessibility standards.
- **Summary:** Implement features that make the app accessible to all users.
- **Importance:** Medium

DR-9: Integration with External Services

- **Description:** Facilitate integration with external platforms, such as tourism information services and other transit systems.
- **Summary:** Enable seamless data exchange with relevant external services.
- **Importance:** Low

DR-10: Support for Future Transit Developments

- **Description:** Design the app architecture to accommodate future expansions, like the introduction of electric buses or new transit lines.
- **Summary:** Ensure scalability to integrate upcoming transportation initiatives.
- **Importance:** Medium

4- User Requirements

UR-1: Journey Planning

- **Description:** The app shall let users enter start and end points, view multiple route options (including walking legs), and automatically adapt paths when disruptions occur.
- **Summary:** Provide intuitive trip planning with adaptive navigation.
- **Importance:** High

UR-2: Real-Time Information

- **Description:** The app shall display live vehicle positions on a map, estimated arrival times, and crowding levels, plus push notifications for delays or service changes.
- **Summary:** Offer up-to-the-minute transit updates and alerts.
- **Importance:** High

UR-3: Digital Ticketing

- **Description:** The app shall enable in-app purchase, secure storage, and QR-based validation of tickets, supporting credit cards, mobile wallets, and local payment methods.

- **Summary:** Facilitate seamless in-app ticketing and payments.
- **Importance:** High

UR-4: Personalization

- **Description:** The app shall let users save favorite routes/stops, view journey history, set customizable alerts, and choose their preferred language.
- **Summary:** Tailor the app experience to individual user preferences.
- **Importance:** Medium

5- System requirements

SR-1: Route Calculation Engine

- **Description:** The system shall compute optimal routes across Tirana's network in ≤ 3 s, support ≥ 1 000 concurrent requests, and auto-recalculate when live disruptions occur.
- **Summary:** Deliver fast, concurrent route optimization with dynamic updates.
- **Importance:** High

SR-2: Vehicle Tracking Subsystem

- **Description:** The system shall ingest GPS feeds with ≤ 10 m accuracy every 15 s, serve ≥ 40 000 simultaneous map users, and operate robustly over intermittent connectivity.
- **Summary:** Ensure reliable, high-precision tracking at scale.
- **Importance:** High

SR-3: Payment Processing Module

- **Description:** The system shall complete ticket transactions in ≤ 5 s, comply with PCI-DSS, support credit cards, Albanian mobile payments, bank integrations, and maintain $\geq 99.99\%$ record accuracy.
- **Summary:** Securely handle fast, reliable financial transactions.
- **Importance:** High

SR-4: User Authentication Framework

- **Description:** The system shall enforce encrypted login, support biometrics on compatible devices, manage sessions with 30-minute timeouts, and safeguard personal data per industry standards.
- **Summary:** Provide robust, standards-based user security.
- **Importance:** High